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REPORT
ON
REFUSE DISPOSAL
FOR
CENTRAL ONTARIO JOINT PLANNING BOARD

December, 1968

JAMES F. MacLAREN LIMITED CONSULTING ENGINEERS TORONTO - LONDON

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REFERENCE NO. 1059

December 10, 1968

Chairmen and Members,
Central Ontario Joint Planning Board,
c/o William F. H. McAdams, M.T.P.I.C.,
Director of Planning and Secretary-Treasurer,
Oshawa Shopping Centre,
King Street West,
OSHAWA, Ontario.

Report on Refuse Disposal

Dear Sir:

The Central Ontario Joint Planning Board has been concerned with the regional aspects of the problems of refuse disposal for some time. As a result, a regional study of refuse disposal was initiated under the auspices of the Board. We were very pleased to be appointed to carry out this work, and accordingly, submitted an "Interim Report on Refuse Disposal" to the Board in April 1967, as a first stage of the study. This report determined the extent of the problem and outlined in general the terms of reference for the second stage report. Subsequently, by an Agreement dated March 20, 1968, we were appointed by the Board basically to prepare a long-range regional refuse disposal plan. In accordance with the terms of reference the study has now been completed and the observations and recommendations are summarized as follows:

1. A total of about 145,000 tons of refuse will be collected in the Planning Area in 1968. By 1986 the refuse will total about 255,000 tons per year.

2. The best long-term disposal method suitable for the Central Ontario Joint Planning Area is sanitary landfill.

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3. The economic analysis of the refuse disposal system indicates that the operation of a single sanitary landfill in the Planning Area provides the most economical solution to the problem of refuse haul and disposal.

4. The existing sanitary landfill on Ritson Road North in the City of Oshawa is of sufficient size to last approximately two years if all refuse generated in the Planning Area was deposited there.

5. From the alternatives examined it appears at this time that the administration of the regional system could best be accomplished by the Public Works Department of the City of Oshawa.

6. The cost of refuse disposal should be realized by charging for disposal on a per ton basis. In recognition of varying haul distances, provisions should be incorporated in the rate structure to permit a form of equalization of municipal haul rates.

7. Site EW-6 in East Whitby Township should be purchased and developed as the first regional refuse disposal sanitary landfill site.

8. Serious consideration should be given to the acquisition of site D-1 in Darlington Township at an early stage to ensure its use as a sanitary landfill site by about 1983.

The details of data gathering, processing, and analyzing that lead to the development of the regional disposal system and the final observations are included in the following pages.

The observations and recommendations of the report result from a concerted study of all factors and conditions that are important to, and which influence the establishment of, an optimum long-term plan for refuse disposal in the area under the jurisdiction of the Central Ontario Joint Planning Board. By following the recommendations on policy and planning alike, it is believed that the citizens of the Planning Area can be provided economic disposal of refuse with the attendant essential protection of their environment.

A study of this type could not have been undertaken without the active co-operation of a large number of persons representing the many provincial, municipal, public and private organizations which have interests in the refuse disposal problem, and were able to furnish the essential basic data on which the study was based. To all these persons we extend our sincere thanks.

Particularly we wish to express our appreciation for the cordial assistance afforded throughout the entire study by Mr. William F.H. McAdams, Director of Planning, Central Ontario Joint Planning Board, and members of his staff.

All of which is respectfully submitted.

Yours very truly,

D.P. Sexsmith

D.P. Sexsmith,
James F. MacLaren Ltd.

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Definitions

A number of terms relating to the subject of this report will be found in the chapters that follow. To prevent misunderstanding, the following definitions are offered.

Waste	any useless, unwanted or discarded material in the form of solids, liquids or gases.
Refuse	all solid wastes.
Liquid Industrial Waste	any liquid wastes which cannot be discharged to sewers.
Central Ontario Joint Planning Area	The Area comprised of the five municipalities of Oshawa, Whitby, Bowmanville, the Township of East Whitby and the Township of Darlington. Referred to in the report as the Planning Area.
Member Municipality	A municipality included in the Central Ontario Joint Planning Area.

CHAPTER I

INTRODUCTION

A. GENERAL

The Central Ontario Joint Planning Board having been apprised of difficulties with refuse disposal being experienced by some of the member municipalities has been concerned with the regional aspects of this problem for some time. In particular, the Board's Technical Advisory Committee at its meeting of 15 th. November, 1966, was of the unanimous opinion that the problems of industrial waste disposal and to a lesser extent domestic waste disposal were of direct concern to all member municipalities. As a consequence, the Committee recommended to the Board that an area waste disposal study be undertaken and that consultants experienced in this field should be engaged to undertake such a study.

Our firm was pleased to be asked to discuss such a study and in January 1967 we submitted a study proposal to the Board. As a result of the discussions, the proposal included a suggestion that the study be carried out in two stages; the first stage to be a preliminary investigation to define the problem areas and to determine the investigations and studies which would be required to enable the second stage to result in recommendations for a long-term refuse disposal plan for the region.

The first stage, Interim Report on Refuse Disposal was presented to the Board in April 1967. This report determined the extent of the disposal problem and outlined in general the terms of reference for the second stage report. Subsequently, in February 1968, the Board authorized the execution of an engineering agreement for the preparation of a long range regional refuse disposal plan with detailed terms of reference as follows:-

1. Establish classifications and determine the weight of privately and municipally collected refuse generated in each of the municipalities within the Planning Area. This determination is necessary to make realistic estimates of cost of operation of present disposal facilities for each municipality.

2. Study the anticipated future developments of the area with respect to -

   (a) increase of population and its probable location;

   (b) extent and location of future industry.

   This information will enable estimates to be made of future quantities, locations and classification of refuse generation and consequently permit assessment of future requirements for disposal facilities.

3. Determine methods of disposal. This will include a review of the various methods of disposal with respect to local factors to determine the best method or methods of disposal for the region. The most obvious methods to be considered are sanitary landfill and central incineration.

4. Determine possible sites for sanitary landfill and their evaluation with respect to -

   (a) considerations of public acceptance which include isolation, traffic accessibility and future land use;

   (b) considerations to ensure that required pollution abatement goals can be attained; these include such items as topography, groundwater regime, surface drainage and gas travel;

   (c) considerations of cost of development and operation including such items as capacity, location, topography and geology of the site, and also the availability and characteristics of the cover material essential to continuous satisfactory operation.

   This determination would take into account the effect of the waste disposal regulations currently being considered by the Provincial Department of Health.

5. Determine the costs of each of the elements of refuse disposal. This would include not only the costs of the final disposal operation at a landfill site or incinerator, but the cost of hauling the refuse from the last pick-up point on the collection route to the disposal vacility. This haul cost can clearly be a very significant portion of the total disposal cost.

6. Establish a regional refuse disposal plan for a 20-year period. This will include an analysis of various alternatives to ascertain the optimum system of refuse disposal for the Central Ontario region.

7. Determine a staged programme for implementation of the refuse disposal plan. This would include a determination of capital requirements throughout the staging period and annual costs of owning, operating and maintaining the system.

8. Make recommendations on system administration and operation. These would embrace general policy, allocation of costs to particular municipalities and procedures for proper operation of the facilities.

9. Preparations for and attendance at meetings by senior personnel up to a total of 15 man-days to assist in the presentation of the report.

Reports and previous studies reviewed in connection with this study and a list of Agencies concerned with refuse collection and disposal are included as Appendices A and B respectively.

This report is submitted in fulfillment of the requirements of the Engineering Agreement.

B. STUDY AREA

The Central Ontario Joint Planning Area extends along the shore of Lake Ontario with its western boundary coinciding with the eastern boundary of the Metropolitan Toronto Planning Area and has a total area of approximately 223 square miles. Prior to January 1, 1968, the Central Ontario Joint Planning Area was comprised of six municipalities: the City of Oshawa, the Towns of Whitby and Bowmanville and the Townships of Whitby, East Whitby and Darlington. On January 1, 1968, the Town of Whitby, and the Township of Whitby amalgamated to form one municipality; the Town of Whitby.

The area is characterized mainly by the industrial development of the urban centres. The areas of development and directions of development are influenced by several factors not the least of which is the traditional east-west traffic movements near the lakeshore. The aggressive expansion in the area with a consistently high standard of living makes the refuse generation and disposal problems similar to those experienced in many other locations in North America. A very brief resume of the area characteristics assists in understanding some of these problems.

The existing surficial geology is the result of the area's geological history and particularly that of the Pleistocene era. The northern boundary of the area falls approximately on a moraine which forms the drainage divide between Lake Ontario and the Georgian Bay-Lake Simcoe-Trent River systems. This moraine is some 800 to 1000 feet above Lake Ontario. South of the moraine a till plain extends for the width of the Planning Area south for a depth of four to seven miles. The southern limit of the till plain is the shorecliff area of the glacial Lake Iroquois. Extending to the south of the shorecliff is a sand plain varying from one-half mile wide at the western boundary of the Planning Area to three miles wide at the eastern boundary. Extending from the sand plain to Lake Ontario is the clay plain formed in the bed of Lake Iroquois. This clay plain is about seven miles deep on the western boundary and about four miles deep on the eastern boundary.

The topography has been greatly influenced by the drainage pattern. The streams forming the drainage pattern are relatively short and steep with drowned outlets. Four of the streams originate in or near the moraine on the northern boundary and there are several other smaller streams originating in the sand plain.

A topographical feature is the existence of a line of worked out gravel pits extending across the Planning Area near the old Lake Iroquois shoreline.

The three urban municipalities in the Planning Area, particularly Whitby and Oshawa, are quite heavily industrialized. Although the General Motors Assembly Plant is by far the largest single employer, with approximately 20,000 employees, the remainder of the industry is quite diversified.

The population of the Planning Area has been increasing very rapidly, particularly in the urban centres with the estimated 1968 population for the area at 129,670 people. It has been estimated this population will reach 235,000 by 1986.

C. SCOPE

In order to establish specifically the scope of the study it is necessary to define rigidly the material that is to be considered for disposal. A table illustrating the type, composition and origin of refuse has been included in "Municipal Refuse Disposal", a treatise prepared by the American Public Works Association and published by the U.S. Public Administration Service. This table is reproduced as Table I-1.

In this report an attempt has been made to adhere to the nomenclature illustrated by Table I-1.

For the purpose of this report it has been assumed that a regional refuse disposal organization will be responsible for the disposal of all wastes generated in the Planning Area with the exception of excess material which can be classified as "clean fill" such as excess excavated material, top-soil, masonry rubble etc. All other known refuse is considered including municipally and privately collected residential, commercial and industrial refuse, and specific refuse such as fly ash, foundry sand, and liquid wastes.

It is assumed that the regional disposal agency will not be required to dispose of materials generated outside the Planning Area limits, and that the agency will not have any jurisdiction over facilities operated by others outside the Planning Area limits. Thus these materials and facilities were not specifically included in the study except as they affect the existing and proposed disposal facilities to be operated by the regional disposal agency.

It is necessary that a refuse disposal study should include an analysis of problems as far into the future as practicable. Accordingly, an eighteen-year period (1968-1986) was determined as a reasonable design period, so as to correspond to other work being carried out by the Central Ontario Joint Planning Board and the completed population forecasts already prepared by the Board. However, the realization that facilities for refuse disposal will be required far beyond 1986 is a significant feature of the solutions recommended.

In general, the objective of this study was to present economical disposal schemes on a long-range basis within the framework of proven technology and existing requirements of pollution control, the appearance and sanitation of the area and the effect on present practices.

TABLE I-1

REFUSE MATERIALS BY KIND, COMPOSITION, AND SOURCES

Kind	Composition	Sources
Garbage	Wastes from preparation, cooking and serving of food; market wastes; wastes from handling, storage and sale of produce	
Rubbish	Combustible: paper, cartons, boxes, barrels, wood, excelsior, tree branches, yard trimmings, wood furniture, bedding, dunnage. Noncombustible: metals, tin cans, metal furniture, dirt, glass crockery, minerals.	Households, restaurants, institutions, stores, markets
Ashes	Residue from fires used for cooking and heating and from on-site incineration	
Street Refuse	Sweepings, dirt, leaves, catch basin dirt, contents of litter receptacles.	
Dead Animals	Cats, dogs, horses, cows.	Streets, sidewalks, alleys, vacant lots.
Abandoned Vehicles	Unwanted cars and trucks left on public property.	
Industrial Wastes	Food processing wastes, boiler house cinders, lumber scraps, metal scraps, shavings.	Factories, power plants
Demolition Wastes	Lumber, pipes, brick, masonry and other construction materials from razed buildings and other structures.	Demolition sites to be used for new buildings, renewal projects, expressways
Construction Wastes	Scrap, lumber, pipe, other construction materials.	New construction, remodeling
Special Wastes	Hazardous solids and liquids; explosives, pathological wastes, radioactive materials.	Households, hotels, hospitals, institutions, stores, industry
Sewage Treatment Residue	Solids from coarse screening and from grit chambers; septic tank sludge	Sewage treatment plants, septic tanks

CHAPTER II

REFUSE DISPOSAL - GENERAL

A. GENERAL

The effects of pollution on our total environment are presently regarded as one of the most pressing problems which face our scientific and financial resources. In order to maintain the health of the public at a level which may be considered satisfactory, it is necessary that considerable efforts be devoted to understanding and controlling pollution effects.

Although the disposal of refuse has only recently received widespread publicity as a major factor contributing to the level of pollution being experienced throughout North America, most agencies responsible for pollution control have recognized that effective control over this factor must be exercised in order to achieve desirable pollution abatement goals. This realization is evidenced by the increase in the number and severity of laws and regulations governing methods of refuse disposal. Regulations providing for more rigid control over the methods used for refuse disposal are a necessary and reasonable development since all of these methods result in the eventual release of many of the polluting elements inherent in refuse into the atmosphere, water and/or earth. The rate and form which these dispersal media receive pollutants from the refuse are dependent to a large degree on the specific type of disposal utilized.

The problems of waste disposal are more acute in major metropolitan areas than they are in an area like the Central Ontario Joint Planning Area. There is however a need for a sound refuse disposal programme at this time in a region such as the Planning Area so as to avert the acute problems which undoubtedly will arise as growth occurs.

With the increase of public interest in the need for more severe control on environmental pollutants, and in particular refuse disposal, there has been a tremendous increase in basic research of the problem by both the private and public sectors. The results of this work has been a better understanding and documentation of various aspects of the problem such as types and quantity of pollutants, costs, etc., even though there has not been a major breakthrough in the methods or economics of refuse disposal. Although there have been and will continue to be significant changes in various aspects of refuse disposal, it is unlikely that the requirement for improved pollution control will ever be fully satisfied or the cost of disposal substantially reduced.

Much effort has been directed toward the conversion of refuse to a useful product or at least to create a useful facility as a result of the disposal of refuse. This effort is very commendable and must be encouraged. However, caution must be exercised in these endeavours to ensure that the end results do not become pollution hazards or scenic blights that are extremely difficult to correct. In other words, any method of refuse disposal adopted must be directed primarily toward optimum environmental conditions without excessive future maintenance costs.

Past practices, development and research have led to the establishment of methods of refuse disposal which, when managed properly, will satisfy present requirements of pollution control at costs which are not prohibitive. These methods are generally quite traditional but do contain refinements essential to the attainment of the desired results.

It is possible to divide refuse disposal problems and their solutions into three categories. The short-term or immediate problem occurring in the next 3 to 5 years, the interim or intermediate problem arising in 5 to 15 years and the long-term disposal problem which develops beyond 15 years.

By necessity, the solution ot the immediate problem should be a well established disposal method, one for which the technical requirements and economics are well known. The major disposal methods under Part B below fulfill these requirements.

The solution to the intermediate range disposal problem will likely develope from disposal methods and techniques presently being studied and tested, while the solution to the long range problems will probably result from continued research into new and varied methods of disposal, or from the further development of methods used to solve the intermediate range disposal problem.

The following represents a brief description of the methods in present use. Not all of these methods are acceptable generally, and many of them are not applicable in the Planning Area.

B. MAJOR DISPOSAL METHODS

1. Open Dumping and Burning

This method, consisting of dumping refuse on open land and burning it to reduce the volume before final disposal into a landfill is common in many communities, both large and small, because it is simple and economical. It is however one of the least sanitary and most unsatisfactory disposal methods. Often tolerated if the site is sufficiently isolated and if meteorological conditions permit rapid dispersal of smoke and gases into the atmosphere without causing nuisance in populated areas, such dumps invariably harbour rodents and provide breeding places for flies, mosquitoes and other insects.

Open dumping and burning is at present in use in the Planning Area. In many cases burning is sporadic and under control, however it is not an acceptable practice in the Planning Area.

2. Sanitary Landfilling

Sanitary landfilling is one of the most widely used and accepted refuse disposal methods and is the method currently employed in the City of Oshawa for the majority of refuse. When conducted on suitable sites and in the proper manner, it provides satisfactory, economical and nuisance-free disposal for virtually all types of solid wastes. On unsuitable or poorly operated sites, sanitary landfills may cause water and air pollution and nuisance conditions may result from truck traffic, blowing paper, dust and general unsightliness. Rodents, flies and other insects are not a problem to control at properly conducted sanitary landfills.

Since suitable sites are available within reasonable haul distances, sanitary landfill must seriously be considered as a viable disposal method for the Planning Area.

3. Incineration at a Central Plant

Incineration is not a complete disposal method but only a means of reducing the volume of refuse for final disposal at a sanitary landfill. As such, it is used in large areas of concentrated development where space is not available for sanitary landfill. Incineration at a central plant is not used at present by any of the five municipalities in the Planning Area.

Air pollution, truck traffic, odours, litter, noise and general unsightliness are the most common complaints against incinerator plants. However, with proper location, design and operation, these problems can be eliminated or reduced to the point where the incinerator is a nuisance-free disposal facility.

While the incineration process is usually more costly than sanitary landfill, an incinerator plant can often be more centrally located and its higher cost partially offset by savings in refuse hauling costs.

C. OTHER DISPOSAL METHODS

Most of these methods are only intermediate steps which alone do not achieve complete disposal but must be employed in conjunction with one of the major disposal methods discussed previously.

1. Composting

Composting is currently the subject of considerable research and promotion. Composting as a method of refuse disposal is appealing because the end product, humus, is a good soil conditioner. However, the humus is not competative with inorganic fertilizers because of their low cost and ease of application. The chemical fertilizers have virtually eliminated the need for soil conditioners. The economics of operating composting plants has not been proven even in areas where there is a ready market for the humus. Composting of refuse in the Planning Area is not considered to be a practical disposal method.

2. On-Site Grinding

On-site grinding of garbage and discharging to sewers is practiced in many areas in North America. It is also used as a pretreatment by some large industries prior to sanitary landfilling. The use of the sink type grinder is a generally accepted method in areas with separated sewers. However, they dispose of only a small and steadily decreasing percentage of modern refuse. It is not a true disposal method as it merely transfers the problem to one of water pollution control. This practice does eliminate much putrescible material and moisture from the remaining refuse making it easier to store and handle. The practice of using garbage grinders is not widespread in the Planning Area.

3. On-Site Incineration

Some apartment buildings, industries, commercial firms and institutions use on-site incineration to reduce the volume of material to be hauled away. The cost of on-site incineration is likely to increase considerably because of more rigid air pollution control criteria to be applied in the future. Development of refuse bulk handling equipment which compacts refuse directly in a large building is now a practical alternative to on-site incineration eliminating the necessity to incinerate or handle garbage cans and thus will tend to reduce the use of on-site incineration.

4. Feeding of Garbage to Hogs

Feeding of garbage to hogs while still practiced in some areas, has dwindled to insignificance as a disposal method.

5. Mechanical Processing

The use of grinders, balers and other processing equipment to reduce the volume of refuse prior to disposal has been the target of considerable research but to date the utilization of such equipment has not been economically proven. There are indications however that such a system may prove advantageous after further research into dependability, versatility and cost factors.

6. Disposal in the Lake

Refuse disposal in large bodies of water has been tried by cities situated near such resources using such methods as hauling refuse to sea in barges and either dumping or burning or by various land reclamation schemes. The disposal of refuse in the Great Lakes by dumping from barges or by land reclamation, whether behind an earth dyke or not, is discouraged because of the pollution potential that is inherent in this type of disposal. It is possible however to carry out land reclamation using inert fill such as excess excavated material, if the landfilling scheme is tightly controlled as to avoid constructing a potential pollution source. Lake front filling with general municipal refuse is not considered a viable alternative in the Planning Area,however select landfilling with inert wastes may prove advantageous in certain areas of the lake front.

7. Salvaging

Many components of municipal refuse such as rags, glass, ferrous metals and non-ferrous metals have potential salvage value providing a market is available. Generally salvaging at a central disposal facility requires a large amount of hand labour and usually results in numerous piles of salvaged material collecting around the site.

Salvaging as an operation, unless highly mechanized, interferes seriously with the smooth operation of the disposal operation, and is incompatible with one of the primary objectives of disposal; to provide efficient and nuisance-free disposal of refuse.

In general, the only salvage methods warranting consideration are those which: (1) do not interfere with the primary objective of disposal, (2) are largely mechanized and require little labour, and (3) recover items which have remained relatively stable in value and for which markets are reasonably assured in the future.

Salvage of any material requires segregation from other refuse, either at the source or at a central plant. Segregation at the source is generally the most feasible method, but is usually practical only at institutions and commercial or industrial firms where the quantity of salvage justifies the additional expense of separate handling. It is not practical for residential refuse.

Segregation and salvage from municipal refuse at a central plant require provisions for magnetic separation of cans and other ferrous metals and handpicking of other salvable items. Salvage is often considered in conjunction with composting because some of the salvable items should be separated from the material to be composted. Some of this separation can be done mechanically but much hand labour is required for a high degree of salvage. Cans and ferrous metals can be salvaged mechanically from incinerator residue.

Paper and paper products, which constitute a major portion of refuse today, have little or no resale value unless they are clean, and they cannot remain clean when mixed and handled with other refuse. Tin cans constitute the largest source of metal in municipal refuse. Miscellaneous ferrous and nonferrous metals must be handpicked from conveyor belts. In these days of high labour costs, the cost of any manual picking process will probably equal or exceed the value of the salvage.

A typical economic difficulty with salvage operations is that large-scale salvage from municipal refuse may saturate the salvage market and depress prices. In addition, most salvage operations are unsightly, unsanitary, and require much cheap labour for success. It would be difficult to obtain the type of labour needed for economical salvaging from refuse in most communities today.

By contrast with the general inapplicability of salvaging from municipal refuse, salvage is often the most practical means of disposal for bulky metallic wastes which are normally collected separate from other refuse. Auto bodies, large appliances, and bulky scrap metal are extremely difficult to dispose of by incineration and landfill and should not be accepted at these facilities if salvaging is feasible.

Municipalities should encourage private salvage of such materials. It may even be advantageous to pay scrap dealers to take such materials rather than to dispose of them by landfill.

Proper zoning and enforcement are essential to prevent nuisance conditions often associated with salvage yards.

CHAPTER III

EXISTING PRACTICES

A. GENERAL

Refuse collection and disposal practices vary in each of the municipalities in the Planning Area. To determine generally the existing practices in the area, each of the municipalities and some of the major industries were visited.

Within the urban limites, residential collection is generally provided once per week by municipally-owned and operated facilities. Private contractors are generally responsible for the collection of most commercial and industrial refuse with some commercial refuse being collected by the municipally operated vehicles. Disposal by the municipalities is be either sanitary landfilling or open dumping with the private haulers hauling to privately owned open dumps outside the urban limits or to the municipally operated facilities. There are a limited number of on-site incinerators in apartment buildings and industrial plants.

In the rural municipalities regular collection of refuse is usually provided to the small concentrations of population spread throughout the area. In these areas collection is by private hauler with the homeowner contracting directly with the private operator or with the municipality contracting with the private operator. There is little or no commercial and industrial refuse in the rural areas but the little that does exist is disposed of privately.

Generally, the disposal facilities presently operated by the municipalities are reaching their capacity and do not have sufficient capacity to provide service for very long into the future. Those sites which are currently being used will require considerable upgrading with the introduction of new regulations by the Ontario Department of Health. A copy of the regulations in their present form entitled "Tentative Waste Disposal Engineering Standards" is enclosed as Appendix C.

A summary of the individual practices in each municipality is included for detailed reference.

B. AREA MUNICIPALITIES - EXISTING PRACTICES

1. City of Oshawa

Collection:

- residential refuse is collected once a week.
- commercial refuse is collected daily in some locations and weekly in other locations by the municipality.
- Remainder of commercial refuse is collected privately;
- most industrial refuse is collected privately.

Disposal:

- a sanitary landfill is operated on Ritson Road at the North City limit;
- all residential and commercial refuse is disposed of at the site;
- some industrial wastes are disposed of at the site;
- the refuse is covered with earth daily
- some on-site incinerators are used in apartments and industrial plants.
- some special refuse such as waste glass are disposed of privately by dumping
- the majority of waste generated by General Motors Limited is disposed of by a private hauler at a disposal site outside the city limits.

2. Town of Whitby

Collection:

- residential refuse in the original town area is collected once a week by municipally owned and operated packer trucks;
- domestic refuse in the rural areas, such as in the Brooklin area is collected once per week by a private hauler under contract to the municipality.
- a portion of the commercial refuse is collected 2 times a week by the municipality;
- industrial and remaining commercial refuse is collected by private haulers;

Disposal:

- a landfill site on Hopkins Street was operated by the municipality up to June 1968 at which time it was permanently closed. Refuse was covered intermittently by a bulldozer;

- since June 1968 all refuse from the original town area has been disposed of at a site just east of Highway 12 south of Brooklin along with refuse from the rural areas. Refuse is burned and covered intermittently with a bulldozer.
- industrial wastes are disposed of privately, some at the municipal disposal site and the remainder at private sites

3. Town of Bowmanville

Collection:

- residential refuse is collected once per week by a municipally operated packer truck;
- most commercial refuse is collected by the municipality twice per week.
- some commercial and all industrial refuse is privately collected.

Disposal:

- a disposal site is operated by the municipality on Jackman Road adjacent to the Bowmanville Creek. The site is an open dump where some illicit burning takes place. Refuse is intermittently covered;
- all commercial and residential refuse is disposed of at the site. No industrial wastes are accepted.
- a tree disposal site is located on Liberty Street;
- on-site incinerators are used by industry to a limited extent.
- most industrial refuse is disposed of privately outside the town limits in privately owned disposal sites

4. Township of East Whitby

Collection:

- residential refuse is collected once per week by a private hauler in certain areas
- industrial and commercial refuse in the township is negligible.

Disposal:

- refuse collected is disposed of at the City of Oshawa disposal site, and the Township pays a fee for this service.
- a privately owned and operated site, accepts the majority refuse generated by General Motors Limited. This disposal site is an open dump with only the minimum amount of cover material used.

5. Township of Darlington

Collection:

- residential refuse is collected once per week by a private contractor in certain areas
- the cost of collection is paid for directly by each householder;
- commercial and industrial refuse is collected by private haulers:

Disposal:

- a disposal site is located at Maple Grove. The site is an open dump where burning takes place;
- a second disposal site is operated on Tyron Road at the north end of the Township. This site is also an open dump with some burning;
- a private site is operated north of Courtice for the disposal of fly ash and foundry sand.
- a private site at Harmer's Gravel Pit about 5 miles north of Bowmanville is operated for the disposal of industrial refuse.

C. LIQUID INDUSTRIAL WASTES

For the purposes of this study, a liquid industrial waste may be defined as any liquid which because of its physical and/or chemical composition cannot be discharged directly into a municipal sewer because of certain objectionable physical or chemical properties. The physical and chemical properties of liquid industrial wastes vary widely, some being highly fluid (e.g. spent varsol or paint thinner) while others may be much more viscous (e.g. paint sludge). Some of the more familiar liquid industrial wastes are:-

(i) Waste oils from machinery gear boxes, and hydraulic systems. The inflammable nature of these wastes, and in some cases their sludge-like consistency precludes the posibility of discharging them to municipal sewers.

(ii) Spent acids and alkaline solutions used for cleaning metal surfaces prior to painting or plating. If discharged to municipal sewers without pretreatment, these wastes would tend to corrode sewers and upset sewage treatment plants employing biological processes.

(iii) Inflammable paint thinners, paint sludges, and cleaning solvents such as spent varsol, etc.

In the study area, liquid industrial wastes are currently being disposed of by one of the following methods:-

(a) The waste may be trucked to a landfill disposal site in drums or in a tank truck, dumped into a seepage pit and allowed to soak away.

(b) The waste may be treated chemically by the industry and then discharged to the municipal sewerage system.

(c) The waste may be treated by the industry with a view to recovering useful by-products, e.g.: ion exchange units are often used to recover valuable metallic ions from spent plating solutions.

(d) The wastes may be lagooned near the plant to allow certain solids to settle out after which the clarified effluent may outfall to a nearby water course or storm sewer.

(e) Limited quantities of acidic wastes are dumped into small lime seepage pits on the premises and allowed to soak away, the intent being to neutralize the acidic wastewater with lime before it comes into contact with groundwater

(f) Limited quantities are mixed in with solid refuse where they may be soaked up by materials such as cardboard, paper etc. Alternately, they may be disposed of in sealed containers with solid refuse.

(g) Waste oils from service stations and industries may be used for dust control on gravel roads and parking lots or may be re-refined by companies specializing in that type of work.

(h) It is believed that certain indeterminate quantities of liquid wastes are being disposed of in an uncontrolled manner into lakes, streams, sewers, watercourses or on rural lands in the study area.

It should be emphasized that several industries in the study area have installed, or are planning to install excellent facilities for treating industrial wastes. However, a great deal more work remains to be done if the pollutional effects of these wastes are to be eliminated completely.

CHAPTER IV

METHODS OF STUDY

A. GENERAL

In a study to determine a long term regional plan for refuse disposal, the basic problem is to compile and arrange data in a form that can be readily manipulated to permit meaningful physical and economic comparisons of various alternative schemes. The basic elements that comprise the study are the quantities, the applicable disposal methods, the evaluation of existing disposal facilities, the location of possible future facilities, the costs of various solutions and the organizational and operational requirements of the future disposal facilities. The following represents a brief summary of the steps taken to accomplish the required objectives.

B. EXISTING PRACTICES, QUANTITIES AND COSTS

As refuse in the Planning Area is collected and disposed of either by municipally or privately operated systems the present practices of the five member municipalities, the major private waste haulers and the major industries were compiled and reviewed. The known disposal facilities were also visited. Records of past refuse generation were not complete and it was necessary to monitor the major disposal sites to supplement the existing information. The current and past expenditures for the collection and disposal of refuse in Oshawa, Whitby and Bowmanville were reviewed in detail. Considerable effort was expended in attempts to ensure that the elements used to compile the cost of various functions were consistent for the various municipalities even though their present practices vary considerably especially where overhead costs and employee benefits are concerned. Contacts were also made with a number of industries and private haulers to review their specific problems. From these steps existing quantities and variations throughout the year, practices and costs were established.

C. USE OF PLANNING DISTRICTS

The planning districts and sub-districts as established by the Central Ontario Joint Planning Board for use in connection with other Board activities represent an area the size of which is manageable from the standpoint of refuse quantity calculations and were used as the basic unit of refuse generation. Past and present data on population, commercial, and industrial landuse, developed by the Central Ontario Joint Planning Board for each of the planning districts was used as the basis for forecasting future population and commercial and industrial land use statistics. These demographic studies in turn were used to project the refuse generation quantities on a per capita or per acre basis. The estimated refuse quantities and the geographical location of the planning districts were used for the economic analysis of various disposal alternatives.

D. SPECIAL MATERIALS FOR DISPOSAL

Special materials such as liquids, used lumber, trees and brush, and demolition wastes are generated in significant quantities in the area. These materials generally speaking have special disposal problems which are somewhat different from the problems experienced with the disposal of residential and the majority of industrial wastes. The disposal of these special materials has been considered additive to the general refuse disposal plan and as such their quantities were not used for the economic comparisons of various alternatives in the development of the overall refuse disposal plan. Special solid industrial wastes such as fly ash and foundry sand, which are also generated in significant quantities, have also been separated from the other industrial wastes since they too have special disposal problems.

E. INVESTIGATIONS OF METHODS AND SITES

In order to evaluate possible disposal methods for their applicability to the Planning Area various alternatives were investigated through literature surveys, interviews with various agencies and visits to view and discuss various operating facilities. From these investigations and previous experience the method or methods best suited to solve the problem of refuse disposal in the Planning Area were selected.

Possible sites for sanitary landfills were located, investigated and analysed extensively to enable reasonable costs for their development and use to be determined.

Alternative types of incinerators were reviewed and analysed to determine the present and future role of incineration in the Planning Area.

F. COSTING

Sufficient preliminary design of potential landfill facilities, and incinerators was carried out to permit the cost of development, operation and maintenance to be estimated with meaningful accuracy. Reasonable haul costs to be experienced by the participating municipalities and private haulers were determined through the examination of present municipal and private haul costs. Labour costs and overhead costs that appeared reasonable were calculated using existing cost data obtained from Oshawa, Whitby and Bowmanville.

G. ECONOMIC COMPARISONS

Alternative disposal plans were analysed economically to select a plan that would minimize the total cost of refuse haul and disposal in the Planning Area.

H. RECOMMENDATIONS

Recommendations are based on the analyses of the economic comparisons tempered by other pertinent factors which are impossible to evaluate in monetary terms such as the provision of sufficient flexibility to permit ready changes in the disposal system should the character and volume of refuse generated change. The recommendations also provide for a system that in general can be extended significantly beyond the design period.

CHAPTER V

REFUSE QUANTITIES

A. GENERAL

For the purpose of determining the necessary facilities and capacity required for future refuse disposal, it was essential to first estimate present and future quantities of refuse generated in the sixteen planning districts (See Figure V-1) comprising the Central Ontario Joint Planning Area.

A number of variable factors influence the production of future refuse and the use of disposal facilities. These factors make it difficult to predict with a high degree of confidence, the subsequent load on the Planning Area disposal facilities.

These include:

1. Alternate and improved methods of food preparation, developments in packaging techniques and merchandising, and changes in community life which may substantially effect refuse composition and quantities generated on a per capita basis.

2. Changes in commercial and industrial refuse production resulting from modifications in existing activity or construction of new activities.

3. Changes in refuse collection, transporting and disposal systems and equipment which could alter the economics of refuse disposal and/or the form in which the refuse reaches the disposal facilities.

Thus any forecast of future load on a disposal facility, regardless of the extent of prior study, must be considered only an estimate based on current conditions.

Refuse is a very heterogeneous material varying in chemical and physical composition. Depending on its form, handling and the collection equipment it is subjected to, its density at delivery to a disposal site varies tremendously. Refuse in a properly operated landfill operation is subjected to greater crushing and compaction effort than is normal in collection vehicles. Thus the in-place density in a landfill is more uniform than the as-delivered density. Hence, the capacity of a landfill site which is related to the in-place refuse density can be more accurately determined from as-delivered weight than from as-delivered volume. In fact, the normal method of determining capacity in a sanitary landfill site is by weight. Design capacities of incinerators are also based on weight. The as-delivered weight can be determined accurately by scaled whereas the as-delivered volume varies according to the type, capacity and percentage load of the delivery vehicles. Thus, measurement of quantities of refuse by weight is to be preferred.

A reasonably accurate measurement of refuse quantities is necessary in order to determine initial disposal costs and to provide for future additions and/or improvements to the disposal facilities.

B. QUANTITIES OF SOLID REFUSE

1. Sources of Refuse Quantity Data

(a) Historical records: Officials of municipalities in the Planning Area were interviewed to discuss their refuse collection and disposal operations and to obtain any available refuse quantity data.

(b) Refuse weights:Since in the past, none of the refuse collected by the municipalities or by private haulers had been weighed on a regular basis, it was felt that weighing of municipally collected refuse from the more densely populated centres of Whitby, Oshawa and Bowmanville was necessary in order to estimate the unit weight of residential refuse generated on a per capita per day basis for the planning districts in these municipalities. Accordingly, the residential and commercial refuse collected by municipally operated vehicles of Whitby, Oshawa and Bowmanville was weighed for a period of two weeks using the weighing facilities of private companies.

Most privately collected refuse is disposed of in sanitary landfills located within the Planning Area. Since no weight records were available, it was considered advisable to observe the sanitary landfill sites where most of the privately collected refuse was being disposed of and record data that would serve as a guide in estimating the total annual quantity of this type of refuse.

Permission was received to observe the sanitary landfill sites listed below. The period of time that each site was observed is also noted:

Location of Site	Period of Observation
Oshawa - Ritson Rd. N.	2 weeks
Whitby - Hopkins St.	2 weeks
Bowmanville - Jackman Rd.	2 weeks

The following information was recorded, where appropriate, for each load delivered to the site under observation:

Hauler's name

Truck capacity (tons)

Size of load (% full)

Density (loose, medium, dense)

Percent combustible

Percent non-combustible

Refuse composition

Estimated weight

The number of private cars using the sites was also recorded and an estimated average of each car's contents was added to the residential refuse quantity for the planning districts within the municipalities of Whitby, Oshawa and Bowmanville.

(c) Interviews with private haulers: private haulers of residential, commercial, and industrial refuse were interviewed in order to obtain data on quantities and origin of these types of refuse.

2. Residential Refuse

Refuse defined in this report as residential refuse includes those quantities generated in the residential areas and collected by a municipality or by private haulers under contract to a municipality. At the time of preparation of this report it was estimated that approximately 80% of all residential refuse was being collected and disposed of at municipally operated disposal sites by municipally operated vehicles and approximately 10% of the residential refuse was being collected by private haulers under contract to a municipality or by private arrangement with individual households.

Although it was recognized that at the time of preparation of this report a portion of the residential refuse generated in the Planning Area was not being collected; for the purposes of this study the un-collected quantities were estimated and included in Table V-3. The amount of uncollected residential refuse may be assumed to represent approximately 10% of the total quantity.

(a) Basis for Estimating Quantities

Quantities of residential refuse can be considered to be proportional to the population served. Estimates of the 1968 and future population within the Planning Area have been made, based on population distribution data presented in the "Central Ontario Joint Planning Board Regional Studies Research Programme-Report 3 - Population", prepared in 1967. Estimates of the population within each of the 16 Planning Districts as determined for 1968, 1971 and at five-year intervals through 1986, are presented in Table - V - 1.

Data relating to quantities of refuse, which were acquired by weighing municipal vehicles for a two week period, as previously noted, were distributed to the six Planning Districts comprising the three municipalities. This was accomplished by studying the collection routes in relation to the boundaries of the planning districts. In cases where an entire collection route lay within a planning district, the truck trip and weight data were used directly for that district. Several cases occurred where a collection route took in portions of two or more planning districts; in these cases, an analysis of the route was made so that the appropriate proportion of the total quantity collected could be allocated to the corresponding district. The weights of the quantities collected in planning districts 6, 10, 11, 12, 13 and 16 were then pro-rated to a pounds per capita per day basis.

The population situated in planning districts 6, 10, 11, 12, 13, and 16 represents approximately 80% of the total population of the entire Central Ontario Joint Planning Area, therefore it was considered reasonable to estimate quantities of residential refuse generated in the less densely populated municipalities of East Whitby Township, Darlington Township and the former Township of Whitby by assuming a rate of refuse production equal to the average amount calculated for the planning districts lying within the boundaries of the original town of Whitby, Oshawa and Bowmanville, this was 1.79 pounds per capita per day.

Estimates of per capita per day quantities of residential refuse for all planning districts are shown in Table V-2.

(b) Summary of Quantities

Past experience indicates that quantities of residential refuse vary seasonally. The minimum quantities are collected in January and February and are as much as 20% below average during that time of year. Maximum quantities, up to 10% above average, may be expected to occur during spring cleanup and again during fall cleanup in October.

The estimated seasonal variation is shown graphically in Figure V-2. Accordingly, the pounds per capita per day quantities shown in Table V-2 were reduced by 10% to allow for the spring peak during which the weighing of municipal vehicles took place and site monitoring was completed. The resulting data was then expanded to arrive at the estimated total quantities of residential refuse for 1968 in the 16 planning districts.

Based on information relating to other North American communities it appears that individual refuse production has been increasing at the rate of approximately 1.5 percent per year from 1955 up to the present time. For this study, future estimates of residential refuse include an allowance of 4.5 percent for the period 1968 to 1971 and 7.5 percent for each five-year period to 1986 for this natural increase.

Utilizing population data, as presented in Table V-1, a summary of the estimated quantities of residential refuse generated during 1968 and the projected quantities through 1986 is shown in Table V-3.

3. Commercial Refuse

Refuse as defined in this report as commercial refuse includes commercial type refuse collected by private contractors or municipalities or hauled by the commercial establishments themselves.

(a) Basis for Estimating Quantities

Quantities of commercial refuse were related to the number of acres of land developed for commercial use to provide a means of distributing and projecting the quantity of this type of refuse within the Planning Area.

Commercial landuse projections were developed for the Planning Area. Following consultation with members of the Central Ontario Joint Planning Board, and in light of the expected growth of the whole Planning Area, the predicted commercial landuse figures, appear to be reasonable.

Estimates of the designated commercial land use for 1968, 1971 and at five-year periods through 1986 for each planning district are shown in Table V-4.

Estimated 1968 quantities for commercial refuse have been determined by observations at disposal sites, from interviews with private collectors or by weighing municipal collection vehicles. Based on interviews with collection personnel, it appears that monthly variations throughout the year are not significant and quantities of commercial refuse estimated during the period of monitoring were expanded to a total year's production assuming the period in which the observations occured was average for the year.

In planning districts 10, 11, 12 and 13, commercial refuse was found to average 28 tons per acre per year for each acre of land designated for commercial use. In planning districts 6 and 16 this type of refuse was found to average 40 tons per acre per year and 35 tons per acre per year respectively. For the planning districts where no data was available it was assumed that the rate of generation would be equal to the weighted average quantity calculated for planning districts, 6, 10, 11, 12, 13, and 16. For 1968, this is equal to 30 tons per acre per year.

(b) Summary of Quantities

The future projections for this type of refuse are based on the assumption that there will be no increase in the generation rate per acre over the study period.

A summary of the estimated quantities of commercial refuse during 1968 and projected quantities through 1986 is shown in Table V-5.

4. Industrial Refuse

Refuse as defined in this report as industrial refuse includes industrial type refuse collected by private contractors or hauled by industrial establishments themselves.

(a) Basis for Estimating Quantities

Quantities of industrial refuse were related to the number of acres of land developed for industrial use. These data were used for distributing and projecting the quantity of this type of refuse within the Planning Area.

The determination of developed industrial land use projections was carried out in a manner similar to that used to determine commercial land use projections.

Estimates of the designated industrial land use for 1968, 1971 and at five-year periods through 1986 for each planning district are shown in Table V-6.

Estimated 1968 quantities for this type of refuse have been determined by observations at disposal sites and from interviews with private hauling contractors and industrial establishments. It appears that monthly variations in this type of refuse are not significant and the quantities estimated during the study period were considered to be average and were expanded to represent a total year's production.

Based on the disposal site observations and interviews with private haulers and industrial establishments, the rate of generation of industrial refuse was estimated to be 25 tons per acre per year in planning districts 10, 11, 12 and 13; and 15 tons per acre per year in planning districts 6a, 6b, 6c, 6d and 16; for each acre of land designated for industrial use.

Because of the similarity of industrial development to planning districts 10, 11, 12 and 13, a rate of industrial refuse generation of 25 tons per acre per year was also applied to the planning districts located south of Hwy. No. 401, and in the corridor area between the original Town of Whitby and the City of Oshawa (i. e. 6e; 8a,8b,8c and 15).

Planning districts 1, 2, 3, 4, 5, 7, 9 and 14 were considered to have the lowest rate of industrial refuse generation in the Planning Area. This rate was estimated to equal 10 tons per acre per year. An increase of 7.5% per acre for each 5-year interval through the study period was assumed to reflect the increase in refuse generation resulting from more intensive industrial development in these planning districts.

(b) Summary of Quantities

Future projections for this type of refuse are based on the assumption that no increase in the industrial refuse generation rate per acre will occur in planning districts 6a, 6b, 6c, 6d, 6e, 8a, 8b, 8c, 10, 11, 12, 13,15 and 16 over the study period.

A summary of the estimated quantities of industrial refuse during 1968 and projected quantities through 1986 is shown in Table V-7.

5. Quantities of Refuse Used for Economic Comparisons

Quantities of refuse utilized for the economic comparison studies consist of the estimated quantities of refuse generated in the Central Ontario Joint Planning Area and includes the sum of the residential, commercial and industrial refuse as shown in Tables V-3, V-5, - and V-7.

6. Other Solid Wastes

(a) Trees

An effort was made to determine the number of trees cut in the Planning Area each year. From contacts with the municipalities it was estimated that approximately 400 trees per year are being cut in the Area. The average weight of logs and brush was assumed to be 3 tons per tree and the total tree refuse was estimated at 1, 200 tons per annum.

Since there is a large number of dead elm trees in the Planning Area it has been assumed that a total of 1, 200 tons of this material will continue to be produced per year.

(b) Demolition Refuse

Demolition refuse has been classified into two main components for this study. One component is scrap lumber resulting from the demolition of old buildings, and the second component consists of broken concrete, brick, plaster and other inert material resulting from new construction and the demolition of old buildings.

Lumber removed from old buildings is usually damaged to such an extent during removal that it is not normally reusable, and is generally disposed of at one of the landfill sites in the Planning Area.

Demolition refuse consisting of broken concrete, brick, plaster and other inorganic material is generally disposed of by filling in the basement of the demolished building or is hauled away. This type of building rubble is a more desirable refuse since it can be deposited in river valleys for bank protection, or in low areas wherever it is desirable to raise the elevation of the existing ground prior to the construction of new buildings.

It is readily apparent that there is no reliable basis for estimating future quantities of refuse from demolition operations since this type of refuse should increase or decrease in direct proportion to the rate of demolition or construction of buildings. From investigation of available information relating to demolition refuse generated in urban centres throughout North America, including Metropolitan Toronto, it is estimated that there will be an average of 7500 tons of demolition refuse to be disposed of each year within the Planning Area.

(c) Fly Ash

Approximately 12, 000 tons per year of fly ash are produced by General Motors of Canada Limited and are disposed of by a private hauler at a rented site east of Oshawa. Interviews with industrial establishments throughout the Planning Area indicate that there are no other significant amounts of this type of material being produced and no new sources are anticipated. For this report it has been assumed that the quantity now being generated will remain constant throughout the study period.

(d) Foundry Sand

It was estimated that 22, 000 tons of foundry sand is generated each year by firms engaged in metal casting. This material is presently being disposed of privately and will probably not pose a future disposal problem since it is a relatively inert material. For this report it has been assumed that this quantity will be continued to be produced each year.

(e) Other Miscellaneous Wastes

At the present time the demand for scrap metal, including old automobiles, prevents this type of waste from presenting a disposal problem. It is reasonable to assume that this demand will continue.

Small dead animals are presently disposed of at disposal sites. There is no reason not to continue this practice in the future.

7. Summary of Solid Waste Quantities

A summary of the estimated quantities of each type of solid waste generated in the Area during 1968 and through 1986 is shown in Table V-8.

C. LIQUID INDUSTRIAL WASTES

1. Classification of Liquid Wastes

The liquid wastes generated in the study area generally fall into one of the following categories: (a) inflammable, (b) acidic, (c) alkaline, and (d) miscellaneous. These terms are used in a fairly broad sense as clarified below:

(a) Inflammable Wastes

Inflammable liquid wastes include such materials as paint solvents and thinners, cleaning fluids, contaminated oils, and a host of other petrochemical derivatives.

(b) Acidic Wastes

The term "liquid acidic wastes" generally infers liquids whose p^H measures less than 5.0. Wastes which are only mildly acidic may be discharged into a sanitary sewer provided their content of heavy metals, salts and other toxic materials does not exceed the limits set out in local sewer by-laws. Wastes having a low p^H usually contain varying quantities of strong mineral acids such as hydrochloric or sulphuric acid, all of which are corrosive to sewerage systems, and toxic to the micro-organisms present in treatment plants employing biological processes. The majority of the acidic wastes generated in the study area seem to result from the cleaning of metal surfaces prior to plating, painting, anodizing or other metal finishing processes.

(c) Alkaline Wastes

In this study, the term "alkaline liquid wastes" infers a fluid of relatively high p^H (usually above 8.0) which cannot be discharged directly into a municipal sewer without some form of pre-treatment. A number of reasons may be cited for excluding these wastes from sewers, including their tendency to corrode or clog sewers and their potential toxicity to micro-organisms present in sewage treatment plants employing biological processes. The majority of the alkaline wastes generated in the study area seem to result from metal finishing operations.

(d) Miscellaneous Wastes

The wastes falling into this category include a variety of industrial wastewaters such as wet scrubber effluents from air pollution control devices, sludges from metal cleaning operations, cooling waters contaminated with mill scale, boiler and cooling tower blowdown etc.

2. Quantities of Liquid Wastes

(a) Current Quantitites

The most voluminous liquid industrial wastes which are trucked away from industries and commercial establishments in the study area are the inflammable materials. Based on discussions with officials in industry, municipalities and the Ontario Water Resources Commission our estimate of these quantities is as follows:

(i)	Used oils from service stations and industries	4000 - 5000 gallons/week
(ii)	Other inflammables such as paint solvents, paint sludges and cleaning fluids	2500 - 3500 gallons/week
	Total inflammables	6500 - 8500 gallons/week

It should be emphasized that the foregoing figures represent average weekly volumes generated. During periods of plant shutdown for annual vacations, maintenance procedures are often carried out on plant machinery at which time the oil in hydraulic systems and gear boxes may be changed in several industries. This gives rise to peak volumes of waste oil being generated for about a two or three week period and it is estimated that these peak volumes could be as much as five times the average values quoted. Fortunately, these peaks occur during the summer months when the demand for used oil for dust control purposes is maximum.

All waste oils from the study area are now being re-refined by specialist companies in The Metro Toronto area or are being used for dust control on private roads, in gravel pit areas, on unpaved parking lots etc. From discussions with officials of the companies engaged in oil re-refining, it would appear that this situation is not likely to change during the next ten years so far as the study area is concerned, for re-refined oil. After 1980, it is possible that the disposal of waste oils could become a problem.

So far as can be reasonably determined, essentially all inflammable liquid wastes, other than oils, are being disposed of in existing landfill sites or on private lands; in most instances, it would appear that these wastes are taken to the landfill sites in metal containers and disposed of together with solid wastes.

A survey of all major industries in the study area, and discussions with officials of the Ontario Water Resources Commission reveals that the bulk of the acidic and alkaline wastes generated are being neutralized by the industries themselves, after which the treated effluents are discharged to sanitary sewers. An indeterminate volume of these wastes is being disposed of on private lands by the haulers of septic tank wastes. However, it is believed that this volume if relatively small (probably less than 5% of the total) when compared to the volumes that are being satisfactorily neutralized and discharged into the municipal sewers.

In the neutralization reactions involving acid and alkaline wastes, varying quantities of sludges may be precipitated depending on the chemicals employed. For example, when lime is used to neutralize an acidic waste, a sludge is almost invariably produced due to the relatively low solubility of most calcium compounds. On the other hand, if sodium hydroxide is used to neutralize the same acidic waste, very little sludge will result because of the high solubility of most sodium compounds. Unfortunately, the cost of neutralization with sodium hydroxide is usually between 5 and 10 times the cost of equivalent neutralization with lime. The estimated quantities of acidic and alkaline wastes exclusive of those which are treated and discharged to the municipal sewers is as follows:

- plating sludges from neutralization of acidic and alkaline wastewaters	- 15,000 gallons/week
- acidic and alkaline wastewaters	- 500 gallons/week

Wastewaters coming under the heading of "miscellaneous liquid industrial wastes" include the following:

- spent activated carbon sludge used for the filtering of plating solutions	- 500 gallons/week
- scrubber effluents from air pollution control devices	- 10,000 gallons/week
- wastewaters containing inert solids from grinding and similar operations	- 700 gallons/week
- viscous wastewater containing carbon black, rubber and some oil	- 450 gallons/week
Total Miscellaneous Wastes	11,650 gallons/week

In all probability this figure should be rounded off to about 12,000 gallons/week to allow for smaller industries that were not canvassed or inaccuracies in reporting by the industries that were canvassed.

Summary of Liquid Industrial Waste Quantities

(i) Inflammables

- used oils	- 4000 to 5000 gallons/week
- Other inflammables	- 2500 to 3500 gallons/week
Total Inflammables	6500 to 8500 gallons/week

(ii) Acidic and Alkaline Wastes

- plating sludges from the neutralization of acidic and alkaline wastewaters	- 15,000 gallons/week
- untreated alkaline and acidic wastewaters	- 500 gallons/week

(iii) Miscellaneous Liquids

- Wastewaters and Sludges	- 12,000 gallons/week

(b) Future Quantities

Science and technology is advancing at such a rapid pace that it is virtually impossible to predict future volumes of liquid wastes.

For any given municipality, there are several factors which could profoundly affect liquid industrial waste quantities; some tend to increase the quantities while others tend to decrease them. The following are perhaps the most significant factors:

(i) expansion of industry will usually tend to increase liquid waste quantities;

(ii) development of new products (e.g., new plastics) within an existing industry could increase liquid waste quantities;

(iii) loss of certain markets could transform saleable liquids into waste liquids. For example, used motor oils from service stations are either being re-refined or used for dust control on private and temporary gravel roads. As more and more roads become paved, the market for used motor oil could decrease; at the same time, the number of automobiles will inevitably increase resulting in greater quantities of used motor oil to serve a dwindling market.

(iv) The opening up of new markets could make it attractive to transform waste products into saleable products. For example, hydrofluosilicic acid was once considered a useless liquid waste. Today it is widely used for fluoridating water supplies.

(v) Process changes within an industry could either increase or decrease liquid waste quantities. For example, in the plating industry, the introduction of high pressure "fog sprays" to replace rinse tanks reduces liquid waste quantities.

(vi) Development of new treatment facilities will generally eliminate or reduce liquid wastes - e. g., acid recovery units in steel mills eliminate "pickle liquor" wastes.

(vii) Substitution of certain products could increase or decrease liquid waste quantities. For example, the use of plastic grills, hard rubber bumpers and fibreglass bodies may become more widespread in the automobile industry in future. Such changes would eliminate many plating and metal finishing wastes but would undoubtedly introduce new liquid wastes of an organic nature.

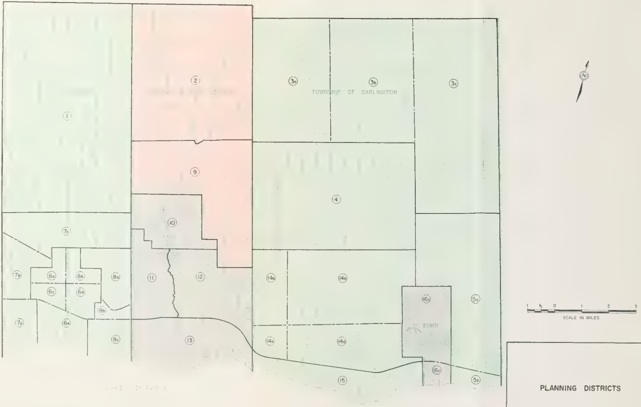
Finally, it should be pointed out that liquid industrial wastes might show an apparent increase in the near future if the following takes place:

(i) if the study area municipalities provide extensive; and readily accessible disposal facilities for liquid wastes; and

(ii) if regulatory agencies such as Ontario Water Resources Commission or the Department of Health are given stronger legislation and provided with larger staffs for policing waste disposal practices.

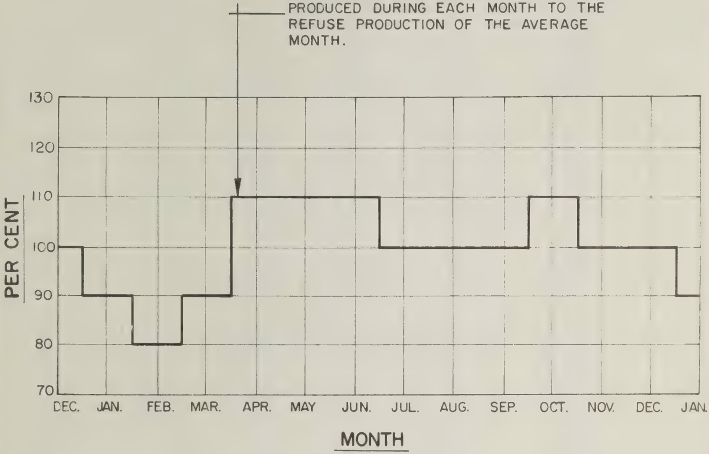
In reality this apparent increase might represent liquid wastes which it is believed are now being desposed of in an uncontrolled manner, or are being included with solid refuse.

Because of the foregoing reasons an attempt to predict future liquid waste quantities does not appear warranted at this time.



PLANNING DISTRICTS

FIG. V-1



RATIO OF THE WEIGHTED AVERAGE OF REFUSE PRODUCED DURING EACH MONTH TO THE REFUSE PRODUCTION OF THE AVERAGE MONTH.

MONTHLY REFUSE PRODUCTION

(EXPRESSED AS A PERCENT OF AVERAGE MONTH)

FIG. V-2

TABLE V-1

POPULATION PROJECTION

CENTRAL ONTARIO JOINT PLANNING BOARD

Planning District	1968	1971	1976	1981	1986
1	3,459	3,600	3,850	4,090	4,350
2	980	1,000	1,100	1,200	1,350
3a	320	330	350	370	400
3b	767	820	880	940	1,000
3c	520	520	520	520	520
4	2,664	2,940	3,400	3,960	4,400
5a)	894	950	1,020	1,120	1,200
5b)					
6a	4,896	5,220	6,040	7,592	9,864
6b	2,527	2,790	3,500	5,174	8,604
6c	3,916	4,180	4,840	6,084	7,992
6d	3,663	3,890	4,460	5,460	6,768
6e	834	920	1,160	1,690	2,772
7a)	686	720	780	850	930
7b)					
7c	771	880	1,150	1,280	1,420
8a	2,925	3,820	5,030	10,080	17,100
8b)	174	180	190	200	200
8c)					
9	2,308	2,500	3,400	4,300	5,650
10	10,894	13,530	18,190	22,750	26,930
11	19,499	21,800	25,790	29,400	32,700
12	42,033	45,270	50,500	55,300	59,760
13	10,650	11,400	12,520	13,550	14,610
14a	2,110	2,327	2,598	3,980	7,484
14b	2,795	2,853	2,932	3,270	4,106
14c	83	90	100	110	120
14d	391	420	450	480	520
15	250	250	250	250	250
16a	300	335	400	480	600
16b	8,371	8,965	10,100	11,520	13,400
Total	129,670	142,500	165,500	196,000	235,000

TABLE V-2

RESIDENTIAL REFUSE GENERATION RATE - 1968

PLANNING DISTRICT	LBS PER CAPITA PER DAY
1	1.79
2	1.79
3	1.79
4	1.79
5	1.79
6a	1.89
6b	1.62
6c	1.80
6d	1.54
6e	1.68
7	1.79
8	1.79
9	1.79
10	1.78
11	1.69
12	1.78
13	1.83
14	1.79
15	1.79
16a	2.09
16b	2.09

TABLE V-3

ESTIMATED REFUSE QUANTITIES

Residential Refuse

Residential Refuse in Tons

Planning District	1968 tons/year	1971 tons/year	1976 tons/year	1981 tons/year	1986 tons/year
1	1010	1097	1265	1440	1651
2	286	305	361	423	512
3a	93	101	115	130	152
3b	224	250	289	331	380
3c	152	158	171	183	197
4	778	896	1117	1395	1670
5a)	261	290	335	394	456
5b)					
6a	1517	1686	2094	2827	3942
6b	677	784	1054	1671	2999
6c	1158	1289	1608	2176	3063
6d	929	1029	1270	1674	2236
6e	230	265	360	561	992
7a)	200	219	256	299	353
7b)					
7c	225	268	378	451	539
8a	854	1164	1652	3550	6491
8b)	51	55	62	70	76
8c)					
9	674	762	1117	1514	2145
10	3182	4124	5975	8013	10223
11	5409	6286	8001	9819	11697
12	12274	13797	16589	19478	22685
13	3188	3558	4204	4896	5679
14a	616	709	853	1402	2841
14b	816	870	963	1152	1559
14c	24	27	33	39	46
14d	114	128	148	169	197
15	73	76	82	88	95
16a	103	120	154	198	266
16b	2872	3207	3889	4751	5943
Total	37990	43520	54395	69094	89085

TABLE V-4

ESTIMATE OF DESIGNATED COMMERCIAL LAND USE

Designated Commercial Land Use in Acres

Planning District	1968 acres	1971 acres	1976 acres	1981 acres	1986 acres
1	19	19	19	19	19
2	7	7	7	7	7
3a	-	-	-	-	-
3b	6	6	6	6	6
3c	1	1	1	1	1
4	15	16	17	18	19
5a)	9	9	9	9	9
5b)					
6a	27	29	33	36	40
6b	18	20	25	29	34
6c	19	21	25	28	32
6d	22	23	25	26	27
6e	7	8	9	10	11
7a)	-	1	2	3	4
7b)					
7c	4	4	4	4	4
8a	36	41	50	59	68
8b)	-	-	1	1	1
8c)					
9	15	16	18	20	22
10	56	64	78	92	107
11	161	161	161	161	161
12	148	158	177	193	209
13	7	8	9	9	10
14a	10	12	16	20	24
14b	17	17	17	17	17
14c	-	-	-	-	-
14d	-	-	-	-	-
15	11	11	11	11	11
16a	1	1	1	1	1
16b	69	69	69	69	69
Total	685	722	790	849	913

TABLE V-5

ESTIMATED REFUSE QUANTITIES

Commercial Refuse

	Commercial Refuse in Tons				
Planning District	1968 tons/year	1971 tons/year	1976 tons/year	1981 tons/year	1986 tons/year
1	570	570	570	570	570
2	210	210	210	210	210
3a	-	-	-	-	-
3b	180	180	180	180	180
3c	30	30	30	30	30
4	450	480	510	540	570
5a) 5b)	270	270	270	270	270
6a	1080	1160	1320	1440	1600
6b	720	800	1000	1160	1360
6c	760	840	1000	1120	1280
6d	880	920	1000	1040	1080
6e	280	320	360	400	440
7a) 7b)	-	30	60	90	120
7c	120	120	120	120	120
8a	1080	1230	1500	1770	2040
8b) 8c)	-	-	30	30	30
9	450	480	540	600	660
10	1568	1792	2184	2576	2996
11	4508	4508	4508	4508	4508
12	4144	4424	4956	5404	5852
13	196	224	252	252	280
14a	300	360	480	600	720
14b	510	510	510	510	510
14c	-	-	-	-	-
14d	-	-	-	-	-
15	330	330	330	330	330
16a	35	35	35	35	35
16b	2415	2415	2415	2415	2415
Total	21086	22238	24370	26200	28206

TABLE V-6

ESTIMATE OF DESIGNATED INDUSTRIAL LAND USE

Designated Industrial Land Use in Acres

Planning District	1968 acres	1971 acres	1976 acres	1981 acres	1986 acres
1	142	123	92	61	31
2	-	-	-	-	-
3a	-	-	-	-	-
3b	-	-	-	-	-
3c	-	-	-	-	-
4	10	8	5	2	0
5a	-	-	-	-	-
5b	-	-	-	-	-
6a	9	11	14	17	22
6b	17	19	23	27	33
6c	7	15	28	41	54
6d	29	55	99	143	186
6e	103	126	165	204	244
7a	-	-	-	-	-
7b	-	-	-	-	-
7c	40	83	154	225	297
8a	-	-	-	-	-
8b	11	28	56	84	113
8c	145	203	300	397	495
9	106	99	87	75	64
10	27	29	33	37	42
11	12	26	50	74	97
12	250	235	210	185	162
13	680	793	981	1,169	1,359
14a	-	2	4	7	10
14b	107	89	59	29	0
14c	-	-	-	-	-
14d	17	43	86	129	173
15	148	228	362	496	632
16a	32	81	162	243	322
16b	40	49	64	79	92
Total	1,932	2,345	3,029	3,724	4,428

TABLE V-7

ESTIMATED REFUSE QUANTITIES

Industrial Refuse

Industrial Refuse in Tons

Planning District	1968 tons/yr	1971 tons/yr	1976 tons/yr	1981 tons/yr	1986 tons/yr
1	1,420	1,285	1,033	736	402
2	-	-	-	-	-
3a	-	-	-	-	-
3b	-	-	-	-	-
3c	-	-	-	-	-
4	100	84	56	24	-
5a	-	-	-	-	-
5b	-	-	-	-	-
6a	135	165	210	255	330
6b	255	285	345	405	495
6c	105	225	420	615	810
6d	435	825	1,485	2,145	2,790
6e	2,575	3,150	4,125	5,100	6,100
7a	-	-	-	-	-
7b	-	-	-	-	-
7c	400	867	1,729	2,716	3,855
8a	-	-	-	-	-
8b	275	700	1,400	2,100	2,825
8c	3,625	5,075	7,500	9,925	12,375
9	1,060	1,035	977	905	831
10	675	725	825	925	1,050
11	300	650	1,250	1,850	2,425
12	6,250	5,875	5,250	4,625	4,050
13	17,000	19,825	24,525	29,225	33,975
14a	-	-21	-45	84	130
14b	1,070	930	663	350	-
14c	-	-	-	-	-
14d	170	449	966	1,557	2,246
15	3,700	5,700	9,050	12,400	15,800
16a	480	1,215	2,430	3,645	4,830
16b	600	735	960	1,185	1,380
Total	40,630	49,821	65,244	80,772	96,699

TABLE V-8

ESTIMATED QUANTITIES OF SOLID WASTES GENERATED IN THE CENTRAL ONTARIO JOINT PLANNING AREA

	Quantities of Refuse (Solid Wastes)				
TYPE OF REFUSE	1968 tons/year	1971 tons/year	1976 tons/year	1981 tons/year	1986 tons/year
Residential Refuse	37, 990	43, 520	54, 395	69, 094	89, 085
Commercial Refuse	21, 086	22, 238	24, 370	26, 200	28, 206
Industrial Refuse	40, 630	49, 821	65, 244	80, 772	96, 699
Total *	99, 706	115, 579	144, 009	176, 066	213, 990

* QUANTITIES USED IN THE ECONOMIC COMPARISON STUDIES.

Other Solid Wastes					
Trees	1, 200	1, 200	1, 200	1, 200	1, 200
Demolition Refuse	7, 500	7, 500	7, 500	7, 500	7, 500
Fly Ash	12, 000	12, 000	12, 000	12, 000	12, 000
Foundry Sand	22, 000	22, 000	22, 000	22, 000	22, 000
Total	42, 700	42, 700	42, 700	42, 700	42, 700

CHAPTER VI

REFUSE HAULING

A. GENERAL

Hauling refuse from the last pickup on the collection route to the point of disposal can be a significant factor in the overall cost of refuse disposal and must be considered in evaluating disposal methods as the overall economy dictates that the lowest total cost for haul and disposal be found.

The cost of refuse hauling is dependent upon such items as labour, equipment amortization, taxes, fees, and insurance which are more directly related to time than distance and for this reason, the type of roads refuse trucks travel over as well as mileage travelled is an important factor to the overall cost. A collection vehicle and crew can obviously travel over high speed highways at a lower cost per mile than on crowded municipal or local streets, or unpaved rural roads. Hence from the standpoints of haul economy and minimum nuisance, as well as the overall minimum cost of the refuse disposal system, it is advantageous for disposal facilities to be accessible by high speed haul routes designed for truck traffic.

Many communities in North America have studied the possibility of utilizing existing or unused rail trackage to haul refuse from a central location to a distant landfill site. In a study recently conducted in the Metropolitan Toronto area, negotiations with the Canadian National and the Canadian Pacific Railways to determine the cost of hauling refuse by rail revealed that the cost of haul was considerably in excess of the cost of other more conventional refuse hauling methods, even when the track was existing and the necessary refuse handling equipment was taken into consideration.

B. HAUL IN COLLECTION VEHICLES

Refuse collected in the Central Ontario Joint Planning Area is hauled in a variety of truck types as well as in cars. Truck capacities range from small pick up trucks and vans to large open or packer type trucks. The majority of commercial and residential refuse collected in the three urban centres of Oshawa, Whitby and Bowmanville is collected in packer type trucks where the refuse densities were found to vary from 474lb/cubic yard to 618 lb/cubic yard for the average truck load.

Costs of hauling refuse in municipal and private collection vehicles were estimated for use in evaluating various disposal methods and sites, and for determining the most economical haul method. The cost of hauling refuse is determined by labour and vehicle costs, refuse payload, and travel speed and distance. In relation to the foregoing therefore it is obvious that haul costs per ton of refuse carried varies virtually directly with speed.

Officials of the larger municipalities and private haulers were interviewed to obtain labour and equipment cost information that could be used to determine reasonable haul costs for municipally and privately collected refuse. The municipal budgets were reviewed to determine the costs of overhead and employee benefits.

Refuse payload data was determined from refuse weight records obtained from data gathered during the period that landfill sites in Oshawa, Whitby and Bowmanville were observed.

The fleet of refuse trucks owned by the City of Oshawa were equipped in 1968 with tachographs, an instrument which records on a day chart all motor speed variations. These when converted to miles per hour gave a complete record of truck speeds for all units. From the tachographs it was found that the average haul speed of trucks in the City of Oshawa varied from 16. 8 mph to 19. 8 mph with the average haul speed of all trucks on all roads being 18. 6 mph.

Haul speeds on rural roads and expressways were estimated by driving over possible routes to determine average speeds. The results of these tests indicated haul speeds of approximately 35 mph could be realized over rural roads and speeds of approximately 40 mph over limited access expressways.

Existing haul costs were computed using data from the sources described above and for municipally collected refuse were found to vary from 32 cents to 53 cents per ton-mile, assuming an average speed of 18 mph.

Existing haul cost data was not available from the private haulers in sufficient detail to determine their specific haul costs. However from our investigations of loads and probable costs from private haulers it was apparent that private haul rates are abnormally high. It is also apparent from our observations that the main reason for the high cost is that the haulers are using inefficient equipment. This being the case it is likely that future competition will force the private haul costs down.

From previous experience it is assumed that a reasonable private haul rate should be three quarters of the municipal haul rate. The main reason for this lower cost is that the private haulers generally pick up in a central location and can use bulk containers, special lifting attachments and one man crews.

The following haul costs are estimated to be reasonable for refuse collected in the Central Ontario Joint Planning Area and have been used in evaluating various disposal methods and sites.

Types of Streets or Roads Travelled	Estimated Haul Speed (Average) mph	Estimated Average Haul Costs for Municipally and Privately Collected Refuse	
		Municipal $/ton-mile	Private $/ton-mile
Local Streets	18	0.39	0.29
Rural Roads	35	0.20	0.15
Expressway or freeways	40	0.18	0.14

C. TRANSFER HAUL

When the distance from a collection route to a disposal site is great, it may be more economical to unload collection vehicles at centrally located transfer stations and haul the refuse from these stations to the disposal site in large capacity tractor-trailers, railroad cars, or other bulk handling conveyances. The economics of transfer are influenced by many factors, including:

(1) capacities of collection and transfer equipment;

(2) number in collection crew travelling to the disposal site;

(3) travel speed, and

(4) transfer station costs.

Most transfer hauling is done with large tractor-trailer units because scheduling and routing problems and necessary rehandling of refuse at the disposal site usually can make other methods of transportation impractical. Both compacting and non-compacting type trailers are available and each type can be loaded to the maximum legal gross vehicle weight with municipally and privately collected refuse.

a) Transfer Systems

Normally, a transfer system consists of two components: (1) a transfer station, where collection trucks unload their refuse into transfer trailers or a storage pit, and (2) transfer vehicles used to transfer the refuse from the station to the disposal sites.

When a transfer system is used as a connecting link between the collection service and the disposal sites it must afford the most economical means of delivering refuse to disposal sites with facilities capable of handling the material without confusion, loss of time, or the creation of nuisances.

In considering the dependability of a transfer system, it must be recognized that a failure at the transfer station or in the transfer hauling operation may seriously disrupt and delay both the collection and disposal processes. There should be ample reserve facilities at the transfer station, including adequate storage capacity, and sufficient reserve hauling vehicles to take care of any emergencies. Collection trucks should have easy access to the unloading points at the transfer station and be able to discharge their loads and return promptly to their collection routes.

Transfer stations should be located as near as possible to the centre of refuse production, preferably in locations zoned for industrial use, and as close as possible to high speed highways.

As stated above two of the factors which determine the feasibility of transfer haul are the capacity of the facility and the distance from the transfer station to the landfill site. In the study area, due to the distance between the three main urban centres, the feasibility of transfer haul was considered for the towns of Whitby and/or Bowmanville.

In a study for the Metropolitan Toronto area on trasfer haul, stations with capacities between 600 and 1200 tons per day were found to meet the requirements in the Metro area at a reasonable cost.

In Whitby and Bowmanville where the annual refuse generated at present is considerably less than 600 T/D (106 T/day and 82 T/day respectively in 1971) a transfer station even of the 600 T/D version would be grossly oversized and consequently very uneconomical.

A study was made into various bulk handling systems available in order to determine whether transfer stations with capacities better suited to the generation rates in Whitby and Bowmanville would be economical.

b) Transfer Stations

Each transfer station would utilize approximately four to six acres of land, depending upon the capacity of the station. The station structure would be similar to a light industrial building, attractive architecturally, completely enclosed and designed to minimize nuisance to surrounding areas. It would be a two level structure with the top level serving as a tipping floor for collection trucks and the lower level housing transfer trailers, storage pit, and garage space for servicing vehicles and other equipment assigned to the transfer station. An office, locker room and lunch room would be provided. Ramps and raised driveway areas would be on earth embankments. All driveways and transfer vehicle parking areas would be paved. Scales and scale house would be provided to permit the weighing of refuse delivered to the station and to weigh loaded transfer trailers to insure that the loads are within the legal limits. It might be possible, depending on the amounts of privately and municipally collected refuse, to delete the scale unit and weigh the refuse at the disposal site provided some arrangement was made to determine the amount of privately collected refuse in the total.

The station would be designed to allow collection trucks to unload directly into transfer trailers or the transfer packer hopper under average operating conditions, or into a storage pit during morning and afternoon peak periods when municipal collection trucks would arrive at the station at a rate faster than the trucks could be unloaded at the transfer trailer stalls. In larger capacity stations all bulky or low density refuse received at the station would be unloaded into the storage pit where it would be crushed and loaded into transfer trailers by bulldozer, while in stations with capacities at the lower end of the scale, these items would be transferred directly as a bulldozer would not be a part of the station equipment.

Refuse from packer collection trucks is sufficiently crushed or compacted, such that a proper payload can be achieved by dumping directly into top opening transfer units. Transfer packers are also available into which the collection trucks discharge and a hydrualic ram forces the material into a specially designed transfer trailer. The number of transfer units would depend on the capacity of the station and the distance to the disposal site from the transfer station.

Each station would be capable of receiving and transferring refuse at a maximum hourly rate of 3 times the average working day hourly rate.

Annual station capacity could be increased within limits by operating longer hours and providing more operating equipment, particularly transfer vehicles.

c) Transfer Vehicles

The type of transfer hauling vehicles considered included truck tractors, with sufficient power to pull the 74,000 pound maximum gross vehicle weight allowed by the Ontario Department of Transport, and top opening semi-trailer units having a capacity of approximately 90 cubic yards of 65 cubic yard closed trailers for use with the transfer packer. The trailers would be capable of hauling a legal payload of about 20 tons, and would be equipped with a cable net arrangement or ejector plate for unloading at the disposal site. They would be covered to prevent refuse from blowing off when enroute to the disposal site.

d) Estimated Transfer Cost

Transfer stations with capacities sufficient to handle the average day refuse generation in 1986 in Whitby and Bowmanville were analysed for use in these municipalities in conjunction with a specific landfill site.

The haul distances from Whitby and Bowmanville are approximately 12 and 15 miles respectively, and based on 1968 cost levels the annual operating cost of a system incorporating transfer from Whitby and Bowmanville is considerably more costly than a disposal system using only direct haul. The transfer costs were based on all private and municipal refuse being handled by the transfer station. It is possible that the competitive position of transfer haul will improve with time as the quantity of refuse handled increases but it is unlikely it will become economical before 1986.

It should be noted also that the competitive position of transfer haul versus direct haul varies directly as the distance between the transfer station and the disposal site and directly as the tonnage of refuse hauled. In the Planning Area the quantity of refuse produced in Whitby and Bowmanville is such that the transfer haul distance must be greater than the 12 or 15 miles to the site in order for transfer haul to be competitive.

CHAPTER VII

SANITARY LANDFILL

A. GENERAL

This section of the report is concerned with presenting a complete analysis of sanitary landfill as an effective solution to the solid waste disposal problem in the Planning Area. To be compatible with the sound principles of sanitation as well as economical, a sanitary landfill must be planned, designed and operated like any other engineering project. "Cheap" and "Convenient" disposal practices can be the most expensive in health and sanitation hazards, and in the lack of adequate public convenience and aesthetics. In recent years, in response to a pressing need for more factual information for evaluating the factors which determine the suitable solution to the problem of refuse disposal and in particular the operation of sanitary landfills, the governments of both the United States and Britain have sponsored research into such problems as the cause and significance of refuse produced leachate and gas pollutants, the effects of water and earth on refuse densities, predictions of landfill settlement and the selection and capabilities of landfill equipment.

B. SANITARY LANDFILL SITE CONSIDERATIONS

The most important step in the development of a satisfactory sanitary landfill programme is the long-range planning and acquisition of suitable disposal sites. The principal criteria considered in determining the suitability of sites for sanitary landfill include capacity, topography, pollution potential, isolation, cover availability, accessibility, existing land use and future land use. An explanation of these criteria and their relation to the Planning Area is included in the following discussion.

1. Site Capacity

Large capacity landfill sites have inherent advantages over small sites. A large site provides greater assurance of continued long-term disposal operations, unit costs for site preparation and completion are normally less, isolation and access for the disposal operation are usually better, and consequently public acceptance is often easier. The difficulty of acquiring and establishing a large landfill site may be no greater than for a much smaller site.

From past experience a site should be used for at least five years to avoid undue relocation costs, disruption to collection systems and unreasonable annual charges necessary to recover the capital required for site development which occur for short lived sites. On this basis only sites with a net refuse capacity in excess of 0.5 million tons should be considered as suitable for a single disposal site system for the Planning Area.

2. Site Topography

The topography of a site determines the type of sanitary landfill operation to be utilized. There are essentially two types of sanitary landfills: area landfills on level or gently sloping sites, and depression landfills on sites that use natural or man-made depressions. Since refuse can be placed to a much greater depth in depressed areas than on level areas where it is undesirable to raise the ground level appreciably above the surrounding grades, depression landfills are usually considered topographically and economically more suitable for sanitary landfill sites.

In the Planning Area the unavailability of sufficient open depressed areas within the three urban communities to meet even the short range requirements of the study period with the exception of the Ritson Road site in Oshawa, deemed it necessary to locate possible future disposal sites in the rural areas surrounding the urban centres.

In view of possible public opposition to the use of prime agricultural land for the location of a sanitary landfill all efforts were made to locate proposed sites in areas where the land was not actively being farmed.

In several communities throughout Ontario the purposes of refuse disposal has been combined with other public purposes into a combined project such as the erection of municipal recreation areas. One of these combined projects which has received considerable publicity is the building of ski hills from solid wastes. This deviation from normal sanitary landfill practice has been embarked upon to provide a more economical use out of flat land areas, subsequently reducing the unit land costs and at the same time creating a useful recreation facility which in turn can be used to offset the cost of its construction.

The construction of ski hills is a relatively new innovation to sanitary landfilling practice and consequently there is an insufficient amount of experience and research data about their construction to provide solutions to the problems of excess gas generation, grass cover maintenance and the availability of sufficient cover material, on the basis of sound engineering. However, from the little information which is available, it appear that the construction of these hills from inert refuse such as fly ash, foundry sand, demolition rubble and excess excavated material and from the majority of industrial refuse which is non putrescible in nature provides a more satisfactory solution with less problems than the construction of such hills from general residential and commercial refuse. The separation of refuse to build a ski hill from inert and industrial refuse alone however requires the simultaneous operation of a second site to provide for disposal of the residential and commercial refuse. This operation of two sites in an area the size of the Planning Area however results in a considerably higher total disposal cost than if only one regional site were used.

It is felt that this method of utilizing landfill space should not be embarked upon at this time but might have value in the future when information on the performance of small trial sites of this nature can be evaluated.

3. Pollution

The possibility that a landfill will pollute the ground and surface waters, pollute the soils and generate combustible gases in the area of the fill is a major consideration in determining the suitability for a site location.

(a) Decomposition

Refuse consists principally of carbohydrates which in sanitary landfills decomposes slowly through an anaerobic process of decomposition. Micro-organisms of the soil and refuse are responsible for this decomposition. Balanced nutrients and moisture are required for optimum growth of micro-organisms and hence for decomposition of refuse. Among many elements needed, carbon and nitrogen are the most important ones. The organic acids of decomposition tend to pickle refuse and after many successive breakdowns through the feeding and growth of micro-organisms and the action of their enzymes, the major end products are carbon dioxide and methane gases and humus material.

The presence of proper micro-organisms, availability of nutrients, degree of compaction, optimum temperature, adequate moisture and proper p^H are the most important factors influencing bio-degradation of refuse in landfills. It is extremely important to note that a positive co-relation exists between the moisture content of the refuse and the rate and composition of the gases produced.

b) Water Pollution by Leachate Removal

The most significant hazard to ground or surface water is the discharge from the fill of a highly polluted fluid. For discharge of this fluid to occur, there must be super-saturation within the fill and the resulting excess fluid produced must be capable of entering the ground water or surface water in the vicinity of the landfill. This excess fluid will contain high concentrations of both organic and inorganic components leached from the mineral elements and products of organic decomposition present in the refuse. The following quotation from a report prepared for the California State Water Pollution Control Board entitled "Report on the Investigation of Leaching of a Sanitary Landfill" 1954, page 74, states that: "Introduction of rubbish into exposed ground water or movement of ground water into and through a landfill during high ground water stages will result in: (a) a serious mineral pollution of the ground water in the vicinity of the landfill; (b) serious organic pollution with a resulting bio-chemical oxygen demand approaching 20,000 ppm and an ammonia nitrogen content as much as 10,000 times that of unpolluted ground water.

"It may be expected that continuous leaching of an acre-foot of sanitary landfill will result in a minimum extraction of approximately 1.5 tons of sodium plus potassium, 1.0 tons of calcium plus magnesium, 0.91 tons of chloride, 0.23 tons of sulphate and 3.9 tons of bicarbonate. Removals of these quantities would take place in less than one year. Removals would continue with subsequent years, but at a very slow rate. It is unlikely that all ions would ever be removed."

Further, from the same report it is noted that to obtain removal from the test bins used in the experiment approximately 100 gallons of water per cubic yard of refuse were required. This means that if the refuse was not placed in or exposed to continuous movement of water from subsurface sources, one acre foot of landfill compacted to a depth of ten feet would require penetration and passage through of 60 inches of water to bring about a similar result. If a landfill site is so selected that water inundation would not be caused by ground or surface water, the only other sources for refuse super-saturation would be water used for refuse compaction, water of decomposition, rainfall and surface runoff. It is highly improbable, if a landfill is properly designed, and operated, that any of the foregoing except compaction water would provide sufficient moisture to produce super-saturation.

In summary, it is evident from the above discussion that a landfill should be constructed above the ground water level and the site designed to prevent any increase in the water content of the refuse.

(c) Hazards of Refuse-Produced Gases

As discussed previously anaerobic decomposition of organic matter in refuse is responsible for the production of both carbon dioxide and combustible gases. Of the combustible gases, methane is the major constituent. The travel of gases in the refuse upward toward the cover surface, horizontally outward and vertically downward into the adjacent soil is a result of build-up of gas concentration gradients between the refuse fill and the overlying cover and surrounding soils.

For most landfills, the problem of gas movement, when it exists, is: (1) the movement of carbon dioxide gas into the subsoil which, due to its solubility in water, may affect the ground water quality; (2) the diffusing of methane vertically and laterally into the adjacent soil and atmosphere which poses a potential explosion hazard when allowed to accumulate in a confined space.

It is not known exactly what effect, if any, the presence of carbon dioxide in the soil has on ground water quality. It is known, however, that refuse-produced carbon dioxide tends to concentrate at the bottom of the refuse-soil interface and pass into the ground. It is also known that carbon dioxide is highly soluble in water and that such acidified water tends to pick up calcium if given the opportunity in the ground. This carbon dioxide therefore may induce an indirect hardening of the ground water depending on the gas concentrations at the fill bottom, upon the nature of the underlying soil and upon the elevation, quality and characteristics of the ground water.

The moisture content of the refuse has a great influence on the composition of the gases produced. Wet refuse produces gases of higher methane concentration than does normally dry refuse. Compositions of gases produced from various fills showed methane concentrations of 50 to 60 per cent by volume for wet fills and never beyond 13 per cent by volume for drier fills.

In summary, refuse fills should be kep above ground water and as dry as possible in order to minimize the production of methane gas and the problem of gas movement into the adjacent soil and contact with ground water. Increasing the water content of the landfill refuse before and/or after filling causes the build up of concentration of combustible gas in the fill and increases the potential for gas movement into the adjacent soil. Reducing the gas concentration gradient between the refuse fill and the surrounding soil will decrease the rate of gas flow from the fill into the surrounding ground. Providing devices to encourage upward gas movement will reduce the rate of horizontal flow into the surrounding ground. Interception of gas flow at the vertical refuse-soil interface through trenches and gas burners may also reduce this horizontal flow. The building of permanent or semi-permanent structures on the surface of completed fills will prevent the upward gas escape and provide a confined space where the gas could accumulate in a combustible concentration.

In particular in the Planning Area, there has been an increasing awareness by all member governments of the need to control potential hazards to water quality. The study area is tributary to streams and rivers which flow into Lake Ontario which is the major source of public water supply to the urban areas. The rural areas and Bowmanville depend on ground water for their water supply. Through legislation, agencies such as the Ontario Water Resources Commission have been given control over the use and quality of these water sources and natural drainage courses. Although the O. W. R. C. and County Health agencies do not have, at the present time, direct legislative authority regarding refuse landfill sites, they can prohibit landfill practices that are causing pollution and request immediate measures to eliminate the pollution source.

The existing geology of the Central Ontario Joint Planning Area makes it extremely difficult to generalize on the ground water regime; however, it is possible to plot and monitor, by subsoil investigation and instrumentation, the elevation, velocity and hydraulic gradient of a local ground water regime and thereby determine the suitability of the site for a sanitary landfill. Some perched water tables do exist in the area and a landfill located against a bank or slope where this exists will in due time become super-saturated and thus a pollution hazard. These perched water tables should be intercepted before the flow can inundate and leach the landfill.

To prevent possible fire hazard by gas movement and ground water contamination by refuse-produced leachage and gases, it is essential that sanitary landfill sites in the Planning Area be located to minimize such a possibility. This requires a location such that:

(i) the lowest elevation of decomposible organic refuse and water soluble wastes be at least 4 feet above the maximum anticipated ground water elevation;

(ii) the fill be protected against the entry of moisture both during and after construction;

(iii) the site be isolated to minimize the possibility of the escape and movement of gases reaching areas where they might be hazardous.

The disposal of liquid wastes in a sanitary landfill is not recommended. They require special safeguards and procedures since they present a serious hazard of water pollution as well as increasing the rate of gas production.

4. Isolation

In any sanitary landfill operation, reasonable isolation is essential to minimize nuisance and ensure public acceptance. Preferably, a landfill should be located in a relatively undeveloped area with a minimum number of residences having a view of the operation or being affected by refuse truck traffic. It should not be exposed to view from a major highway. Where natural screening is not afforded by trees or topography, a permanent perimeter buffer zone and plantings will provide the desired isolation. Alternatively, if ample fill is available, a berm can be constructed to provide the necessary screen.

It must be recognized also that certain types of refuse such as construction debris can be disposed of in relatively unisolated areas without public opposition or nuisance.

5. Cover Availability and Character

An ideal sanitary landfill site should have sufficient earth available to adequately cover refuse deposited therein. The type of earth cover available on a site should be determined by test borings. The soil used as cover material should be of such a character that it can be compacted to provide a tight seal, does not crack excessively when dry, and is relatively free of putrescible material and large objects. The type of soil available is important since it dictates the equipment requirements for excavating, hauling and compacting. The most desirable material is a sandy loam.

The ratio of earth to compacted refuse varies greatly with different landfill operations and daily refuse loadings. For initial site capacity considerations, a ratio of one third daily cover to refuse by volume can be considered reasonable.

Availability of cover on the site or from nearby borrow pits was considered a necessity for proper sanitary landfill operation in the study area. The inherent problems that exist in finding excess excavation material from construction projects and then economically hauling the material make this an unreliable method for obtaining daily cover material.

Site availability of final cover and top soil was also deemed a requirement for site selection. Of the available cover material on a site, 60 per cent was considered for use as daily cover and 40 per cent was considered available for final covering of the fill. Economic comparisons were made in the light of these variations and various site finishing costs reflect this accordingly. Excavation below existing ground levels for cover material was considered only at those sites where ground water elevations permitted or where ground water elevations could be effectively and permanently lowered to the required elevation.

6. Accessibility and Haul Distance

To minimize hauling costs, landfills should be as close to the area of refuse production as possible and accessible via high-speed highways and rural roads to the maximum practical extent. Haul routes which require concentrated refuse truck traffic on residential or commercial streets should be avoided. Local haul roads should be suitable for handling large volumes of truck traffic under all conditions.

Existing and future highways and expressways will provide excellent high-speed haul routes from the areas of heavy refuse production. Local access from these routes, however, presents more of a problem. Since the suitability of any site is dependent on a proper access, the feasibility of providing for such a route must be determined. It is possible for large sites to provide extensive local access road improvement without causing a prohibitive increase to the site disposal cost. For smaller sites, however, the cost of such road improvements can prove to be an inordinate portion of the total development cost.

In this study, it was assumed that intended improvements to county, township and provincial roads could be re-scheduled to meet refuse traffic requirements and that unscheduled improvement to local roads be included in the development cost of the site.

7. Future Land Use

Part of the effective planning and operation of a sanitary landfill is the eventual use of the finished site. It is essential in any future planning to recognize that decomposition of a sanitary landfill is a long term process. The fill should remain undisturbed for a number of years to permit this decomposition to take place. During this time, it is essential that the completed fill be protected and maintained against water inundation. The use of the completed site for building construction will require extensive foundation treatment. Excavations into the fill are not desirable as they can only aggravate the problems of water infiltration and obnoxious odours.

Explosive mixtures of refuse-produced methane and air can and have occurred in buildings resting on landfills. Although special precautions can be taken to prevent such accumulation, the dangers of refuse gas are always present. Therefore, the most logical end use of a sanitary landfill must be for park and recreational purposes where surface drainage, gas and differential settlement problems can be corrected with the minimum of hazard and effort.

The improvement of borrow pit areas is a distinct advantage of sanitary landfilling. However, the main objective of such an installation is effective refuse disposal. In this report, the economic advantage of filling and converting such an area into useful parkland was not estimated nor was the economic loss by area filling of prime land evaluated.

C. SANITARY LANDFILL SITE INVESTIGATIONS

1. Investigation Procedures

Studies were made to ascertain the availability and relative merits of potential sanitary landfill sites to meet immediate and long range refuse disposal needs of the Planning Area. Only sites within the planning area were considered. Initial investigations were guided by the site considerations and criteria discussed previously and include the following principal steps:

(a) all pertinent information on completed, existing and proposed future landfill schemes was gathered from interviews with the area municipalities;

(b) a thorough study was made of the 1:25000 Department of National Defence topographic maps and 1" - 1000' aerial photography to locate sites appearing to meet the general criteria for sanitary landfilling;

(c) an aerial reconnaissance of the planning area was made of sites found from map and photograph studies and to locate other suitable areas not readily evident from the mapping;

(d) field inspections and surveys were made of all sites which appeared favourable from map studies and aerial reconnaissance;

(e) evaluations were made of soil type and availability of cover material from on-site inspections;

(f) water pollution aspects were considered in view of the ground and surface water conditions at each site;

(g) contact prints from the latest aerial photographs and field surveys were used to make preliminary filling plans and volume calculations;

(h) existing and future transportation plans were studied to evaluate the accessibility of the sites.

2. Landfill Site Scoring System

In order to summarize on a comparative basis the findings of the initial site investigations as outlined previously a scoring system was developed. The initial investigations provided some 51 possible landfill sites for further detailed study. Following this, 3 sites were grouped into 1 site and of the 49 individual sites remaining 29 were found unsuitable due to either, insufficient capacity, high ground water pollution potential or excessive distance from the three urban centres. The remaining 20 sites were then evaluated using the scoring system. The site scoring for the 20 preferred sites and the reasons for rejection for the 29 rejected sites are shown in Table VII-1. The establishment of the system and the scoring of landfill sites under the system was completed in the following steps:

(i) Principal Objectives: The principal objectives that a sanitary landfill must satisfy were established and are as follows:

- (a) To avoid jeopardy to public health and safety (1000).
- (b) To be acceptable to the public (900).
- (c) To result in improved land use (600).
- (d) To have significant life in the refuse disposal system (500).
- (e) To dispose of all types of refuse (300).
- (f) To be capable of proper development operation and finishing (300).

The objectives were selected such that they pertain directly to sanitary landfilling.

The objectives were rated according to their order of importance with the most important objective rated 1000 and the others correspondingly less as shown above by the bracketed numbers.

(ii) Site Considerations and Characteristics

Site considerations and characteristics were then listed for each of the preceding major objectives, suchthat the considerations were readily measurable, and also related to the ability of the site to attain that particular objective.

Under each objective the considerations were listed in order of importance and were rated on a scale of 1 to 100. The characteristic which best measured, or had the most influence in measuring the attainment of the objective was given a score of 100. The remaining characteristics were then rated according to their relative merit.

(iii) Site Scoring

The 20 landfill sites that passed the preliminary screening were then scored on a scale of 0 to 10 under each of the characteristics relating to each objective. If the site measured poorly under a particular characteristic it was given a low score whereas a site which fully satisfied a particular characteristic was given a 10. For sites which partially met requirements an intermediate score was estimated. The scoring of each site was done prior to the determining order of importance rating for the objectives and site considerations so that the scoring could be done arbitrarily without knowing the effect of the score on the final total score.

(iv) Score Pro-Rating

The individual scores given each of the possible landfill sites were then pro-rated to reflect the relative importance of the particular characteristic and objective which the score was measuring. The pro-rating also accounted for the different number of characteristics measuring the various objectives. The pro-rated scores were summed for each of the 20 landfill sites.

(v) Results of Scoring System

The final scoring system for the 20 landfill sites is shown in Table VII-I and shows the individual total pro-rated scores for each of the sites.

It should be noted however that the score for each site as determined by the scoring system gives the site an order of desirability relative to the other sites. The scores cannot be construed to give a measure of how much better one site is than another, only that it is better. It should also be noted that the scoring is independent of economic considerations. The economic analysis was carried out separately and for only those sites which fared well in the scoring.

In examining the total scores there was a large difference between the highest and second highest scores and the next major division occurred between the ninth and tenth highest scores. Subsequently, the top nine sites were analyzed economically in order to determine a disposal programme to cover the project period. The economic comparison of these sites is described in detail in Chapter XI.

3. Location of Landfill Sites Investigated

Figures VII-1 shows the location of all potential landfill sites investigated.

D. SANITARY LANDFILL DESIGN AND DEVELOPMENT COSTS

From the initial investigations all but 20 sites were not practical for reasons of water pollution hazard, lack of cover material, insufficient volume and poor accessibility. These 20 were further reduced to 9 from the results of the scoring system, and were investigated in more detail to determine their desirability in long range refuse programme. For site selection and economic comparisons, development plans and cost estimates were prepared for each of these sites.

1. Site Development Considerations

The following principal steps were used in preparing site plans for cost estimates:-

(a) Site Capacities

Site filling plans were prepared using contour maps and contact prints of aerial photographs. Available cover material and net refuse capacities for each site were calculated from these plans using the data collected from field investigations to estimate ground and perched water table elevations. The lowest level of the site was taken to be in general 12 feet below the existing surface for area fills. At sites where ground water was indicated within 4 feet of this elevation perimeter ditches were provided to permit lowering of the water table to this limit. The filling plans were balanced to ensure the required cover to refuse ratio needed to properly finish the site. An in-place refuse density of 700 lbs. per cubic yard was used for the volume to weight conversion. For sites requiring area fills the finish fill surface will be 18 to 20 feet above the existing ground surface.

During the two-week monitoring period at the Ritson Road landfill site in Oshawa a test was conducted to determine the in-place density of refuse. The test was run at two separate disposal faces, one for privately hauled refuse and one for the city-owned disposal trucks. The following table illustrates the results of the test:-

	Description	In Place Density (10 lb. /cu. yd.)
1)	Residential and Commercial Refuse as collected by municipality	1, 420
2)	Commercial and Industrial refuse plus refuse hauled in private cars and small trucks	348
3)	Average Refuse density determined from total refuse weight and total volume consumed at both disposal faces.	818

The in-place density of 700 lb/cubic yard as used for the site capacity determinations is an average figure based on experience as reported from several sources. As the above test results show the wide range over which the densities can vary depending on the type of refuse and the compactive effort applied, the figure of 700 lb/cu. yd. was considered reasonable and conservative.

(b) Site Drainage

For proper drainage all sites were designed for perimeter ditches and culverts to collect surface runoff and intercept possible perched water adjacent to the fill area. Where the ground water table was within 4 feet of the bottom of the fill the perimeter ditches were deepened to permit lowering of the water level under the fill area. Finish contours were designed with maximum side slopes of 3:1 and minimum cross slopes of 1.5 per cent.

(c) Site Isolation

A 300 foot perimeter buffer zone was used to provide proper isolation and possible gas penetration protection. Where necessary, allowance was made for constructing berms to ensure isolation from sight.

(d) Site Preparation

Site preparation included quantity calculations for demolition, clearing and grubbing and stockpiling of top soil. On sites where excavations existed below ground water, an allowance was made for filling in depressions which could hinder surface drainage and collect water during the disposal operations.

(e) Site Facilities

Quantities were calculated for site access roads and allowances made for the improvement or construction of local haul roads where necessary. Roads were designed for all weather conditions to handle the traffic loads envisaged. Included in all estimates was an allowance for perimeter fencing, weigh scales, scale house with employees' facilities and an equipment service building.

(f) Site Finish Requirements

Included in the estimates for each site were costs for placing, spreading and landscaping four feet of final cover and nine inches of top soil, removal of fences and demolition of scales, scale house and equipment shed. Also included was an allowance for hydra seeding to protect the finished surface from erosion. Adjustments were made for importing materials which were not available on the site for the final finish requirements.

2. Site Development and Land Costs

Cost estimates were prepared for each site from the site plans taking into account considerations discussed previously.

Estimates of land costs were estimated from the latest property sales data in the Planning Area.

The investment for land and development costs for the economic comparisons, was amortized at 7 per cent over the life of the site. Since the life expectancy of any site is determined by the rate of filling, curves were developed to show the varying unit cost of owning and developing each site for years of life expectancy.

Figure VII-2 shows such a curve for the proposed East Whitby Site EW-6.

A concise summary of sites used in the economic comparisons is presented in Table VII-2.

E. SANITARY LANDFILL OPERATION AND OPERATING COSTS

In the Central Ontario Joint Planning Area, the suitable methods of sanitary landfilling are the area method for upland, level or gently sloping sites and the depression method for sites where natural or man-made depressions are available.

Depending on site topography and ground water conditions the methods of operation usually used for area landfills are progressive excavation or trench type cut and cover. Where the ground water elevation does not allow deep excavation and the topography is not suitable for a high fill the progressive excavation method of area landfilling is normally used. It is essentially a one-lift continuous operation. Cover material is excavated from the area directly in front of the working face and put over the previously compacted refuse. The daily refuse cells are usually formed by discharging the refuse at the bottom of the lift face where it is spread and compacted from the bottom up. Figure VII-3(a) shows the progressive excavation method of operating an area landfill.

When ground water conditions allow relatively deep excavation the trench type cut and cover method can be utilized. This type of operation normally consists of excavating trenches to hold the refuse and provide a source for cover material.

These trenches are normally excavated parallel to each other and the excavated earth stockpiled for use in the covering operation. If the topography and cover availability allows, the fill can be built up in a number of vertical lifts. The daily refuse cells are formed by discharging refuse at either the bottom or top of the lift face. Figure VII-3(b) shows the trench excavation method of operating an area landfill.

The method of operating a depression fill is somewhat different. Unlike the area method, cover material is transported from sources within the pit and stockpiled for spreading on the compacted surface of the daily cell. The depression fill is built up by a number of lifts. The refuse is transported to the working face either at the top or bottom of the lift face. The lifts are built by spreading and compacting the refuse in cells sized for expected daily loadings similar to the area fill method. Figure VII-4 shows the operation of a depression type fill.

Since the method of cell construction in these two types of operation are essentially the same and investigations indicate the majority of sites available are suitable for an area landfill, the following detailed discussion of operating methods, equipment selection, regulations and costs analysis are based on this type of operation.

1. Methods of Operation

The daily loading of any site is dependent upon the ability of the site and the access routes to accept traffic. The daily loading at present in the Planning Area is estimated to be 460 tons per day assuming all refuse generated in the area is deposited at one site. By 1986 this loading rate is envisaged to reach approximately 860 tons per day. From past experience it has been estimated that under normal operating conditions loading rates up to 2,000 tons per day can be handled at one dumping face provided the site has adequate access facilities. It is therefore reasonable to assume that during the project period that one dumping face can adequately handle all refuse generated in the Planning Area.

(a) Cell Operation

Cells should be sized to accommodate the daily refuse quantities expected at the site. The working face of the cell should be long enough to enable the compaction equipment and the refuse trucks to manoeuvre without undue interference. Refuse should be deposited on the cell working level. Access to the working level would be either from the bottom of the cell or from the adjacent completed lift. Bulldozers would spread and compact the dumped refuse in 12-inch layers. As the day's work progresses and the compacted refuse is built up to the level of the adjacent lift, an earth layer would be placed over the fill material so that the daily refuse would be enclosed in an earth cell.

(b) Lift Height

The maximum depth of any lift should not be greater than eight feet in order to permit proper compaction.

(c) Compaction and Spreading Requirements

Each 12-inch layer of refuse must be thoroughly compacted by continuous travel of the landfill spreading and compaction equipment. The need for good compaction cannot be over-emphasized. The success of a sanitary landfill is largely dependent upon an effective and continuous compaction effort. Proper compaction minimizes settlement, surface cracking and release of odours. Cell sloping surfaces should be constructed at a 3:1 slope to allow for reasonable compaction on the face.

(d) Cover Requirements

A well-compacted layer of at least 9 inches of suitable cover material should be placed on all exposed refuse at the end of each working day. Due to the open nature of the compacted refuse surface, a loose depth of 15 inches of cover material should be spread to give an effective final cover of 9 inches. To prevent moisture penetration, fly and rodent attraction, blowing paper, odours and fire hazards, it is essential that the completed refuse cell be covered daily.

(e) Surface Drainage

Each lift in the filling operation should be graded to allow for proper surface drainage. Temporary ditches should be constructed at each lift elevation to divert the surface drainage away from the filling areas. It is essential that every completed cell conform to the general drainage pattern of its particular lift. The proper drainage of the fill area during construction is necessary to prevent accelerated decomposition and leaching of the refuse.

(f) Winter Operations

The principal problem involved in winter landfill operation is the excavation and spreading of cover material. In areas where dry granular material is available, winter cover operations are not a problem. However, where cover material is susceptible to freezing, special precautions must be taken.

A certain amount of frost in the ground in early winter is little detriment when the earth moving machines are equipped with hydraulic rippers. However, as frost penetration increases, excavation of previously undisturbed earth becomes increasingly difficult. Therefore, excavation during winter should be carried out in a specific area where the operation could be as continuous as possible and not allow deep frost penetration. Such areas could be protected during week-end periods by covering with straw or other such insulating materials.

(g) Site Haul Roads

Site haul and entrance roads should be built and maintained for all weather operation. Temporary roads over various lift elevations should be built and continuously maintained with either gravel or rubble to allow free vehicle movement at all times.

(h) Fire and Dust Control

A suitable water tank truck with pumping and spraying facilities should be available at the site at all times to extinguish possible fires and control dust nuisance.

(i) Blowing Paper

Blowing paper can be controlled by providing portable fencing near the working face.

(j) Vector Control

If sanitary landfill operations are carried out in the manner discussed, conditions for the production of insects and rodents would be unfavourable. However, supplemental vector control measures should be carried out as a routine precaution against health hazards and nuisances.

(k) Supervision of Operation

Sanitary landfill operation should be under the direction of a qualified individual. It is anticipated in the study area that the sites will be staffed with qualified supervisors who can direct the proper operational procedures so that no health nuisance or aesthetic problems will result.

(1) Weighing Facilities

All refuse delivered by collection vehicles to the landfill should be weighed. Weighing provides reliable quantity data to determine trends, and to estimate future disposal needs.

2. Sanitary Landfill Equipment and Labour

The number of persons and the amount of equipment required to operate a sanitary landfill varies with the size and complexity of the operation. For equipment and labour selection it was assumed a landfill site would operate 8 hours per day, 250 days per year, plus a watchman for the remaining time.

Since the site is to accept all refuse in the study area including industrial refuse it is not unlikely that the site will have to be open 24 hours a day 6 days a week to accommodate the industrial private haulers. This requirement could be met by having the night and weekend watchman double as a scaleman and truck spotter. As refuse deposited during the off hours would be primarily of the inert industrial type it would be possible to let the refuse accumulate until the next operating shift before covering.and compacting provided protection from blowing paper was available. The daily loadings envisaged take into account this type of site operation.

The following recommendations for the selection of equipment and labour to operate a sanitary landfill were based on field observations and modifications of performance ratings supplied by the manufacturers. For equipment comparison, performance ratings on daily production were calculated for various sizes and combinations of tractors and scrapers.

(a) Spreading and Compaction Equipment

The basic piece of equipment chosen for spreading and compaction of refuse was the crawler-type tractor. Although this piece of equipment is not specifically designed as a compaction unit, its versatility and ruggedness make it ideal for this type of service.

Performance ratings for these machines were based on the time required to spread the rated blade capacity in 12-inch layers and the time to make two complete passes over the refuse for compaction. The resulting ton-per-day rating was used as the minimum acceptable standard for the spreading and compaction operation. This rating was used to select the number of units to handle refuse loading on the average day of the maximum week. It was assumed that during average day conditions this built-in excess capacity for the maximum week period would be utilized in compaction above the minimum acceptable standard. On this basis, it was estimated that a D8H tractor, or its equivalent, can spread and compact an average of 720 tons of refuse per day and a

D7E tractor, or its equivalent, can spread and compact an average of 560 tons of refuse per day.

The tractors for the spreading and compaction estimates were assumed to be equipped with refuse blades, cabs, cab heaters and standard guard equipment.

The wheel type compactors were not considered in the calculations for the spreading and compaction operation. A wheel type unit does provide adequate compaction but its lack of versatility suggests that it should only be considered as a second piece of compacting equipment.

(b) Equipment for Hauling and Spreading Cover Material

The basic unit chosen for hauling and spreading cover material was the wheeled type tractor-drawn scraper. These units were considered ideal for the hauling and spreading conditions of the depression type sanitary landfill sites where on-site cover material is available.

Performance ratings were calculated on the daily production of various tractor scraper combinations considering an average one-way distance of 1, 000 feet from the cover source. The number of tractor scraper units required on any site was based on the production of material needed to cover refuse on an average daily basis. It was assumed that during below average day conditions, cover material would be stockpiled and used during days of above average conditions.

Based on these requirements, a D8H and 463E scraper, or its equivalent, can cover an average of 1, 070 tons of refuse per day and a D7E and 435E scraper, or its equivalent, can cover an average of 730 tons of refuse per day. Due to the geometry of the daily cell the percentage of cover per ton of refuse varies with the size of the operation. These varying cover-to-refuse relationships were calculated and used to select the required number of units for the daily cover requirements. With the loading rates envisaged in the Planning Area one set of equipment will be adequate throughout the project period; the D7E with the 435E scraper in the early stages and the D8H and the 463E scraper at the end.

The tractor units selected for the cover operation were assumed equipped with dozer blades, power shift transmission, cabs with cab heaters and standard guard equipment. Either this tractor or the one used for refuse compaction was assumed to be equipped with a hydraulic ripper.

(c) Miscellaneous Equipment

Each site was provided with a pick-up truck, water truck, portable lighting equipment, pumping equipment and portable screens.

Road maintenance and general clean-up work around the site was assumed to be carried out by one of the on-site machines or by rental equipment.

Standby equipment was considered unnecessary due to the built-in versatility of the tractor crawlers used with the wheeled scrapers to be utilized on the compaction and spreading operation.

(d) Labour Requirements

The staff necessary to operate each site includes a foreman to direct the operation, heavy equipment operators for tractors and tractor-scrapers, a weighmaster to weigh and record all refuse and a labourer with the spreading and compaction unit to help direct dumping operations and maintain the site. In addition, watchmen would be needed at all times when the main working crew was not on the site. As stated earlier the watchman would need to be skilled in operating the scale.

3. Sanitary Landfill Operating Costs

The cost of operating a sanitary landfill varies with the amount of refuse handled at the site. Costs were developed for various rates of average daily loadings from the equipment and labour selection studies. These costs were based on an operating schedule of 8 hours per day, five days per week for a depression type fill with cover material available on the site. From the various combinations and sizes of equipment, the most economical selection was determined for each range of loading.

The operating costs of a sanitary landfill includes fixed and variable equipment costs, labour costs, utilities, and over-heads. A discussion of the development of these costs is included in the following paragraphs.

(a) Fixed Equipment Costs

The capital cost of purchasing landfill equipment was assumed, for reasonable comparison, to be amortized at 7 per cent over the life of the individual units. The track-type crawlers and graders were assumed to have a 5-year, or 10,000 hours, operating life and the wheel-type scrapers were considered replaceable after 10 years, or 20,000 hours, service. Equipment purchasing costs were developed from 1968 price quotations. An allowance of 10 per cent for contingency items was included in the fixed equipment costs.

(b) Variable Equipment Costs

The variable costs of operating and maintaining equipment for sanitary landfill conditions were developed from manufacturer's performance and service records and based on local current prices.

The operating costs include fuel, oil, grease and all consumable items. The maintenance costs include all labour, parts and materials necessary to properly service the equipment during its operating life.

Initial quotations indicate that the most feasible solution for equipment service and maintenance might be a service contract with a local dealer. An alternative is to provide maintenance crews.

(c) Labour Costs and Utilities

Wages for site personnel were based on the 1968 City of Oshawa rates. An allowance of 50 per cent for overhead to compensate for the indirect charge of supervisory and clerical staff and employee benefits was included in the labour cost calculations. The allowance was determined from the examination of the present budgets of Oshawa, Whitby and Bowmanville and from past experience, to be a reasonable allowance for the items it covers. A cost allowance for utilities was included for all services necessary to properly operate the site.

The cost for operating any sanitary landfill with cover material available on the site for various daily loadings is shown in Figure VII-5. This curve represents the total unit cost of fixed and variable equipment, labour, utilities, and overheads necessary for operating a sanitary landfill over a wide range of average daily loadings. It is important to note from this curve that for economy of operation, the disposal operation should be as large as traffic will permit.

4. Sanitary Landfill Regulations

To properly operate a sanitary landfill, it is important to adhere to strict regulations to control the efficient and safe disposal of refuse.

The following paragraphs describing the operating regulations should be read in conjunction with Appendix "C" 'Tentative Waste Disposal Engineering Standards' by the Ontario Department of Public Health for a more complete understanding of operating procedures.

(a) Operating Hours

The hours of operation should be closely phased with the refuse collection schedule. Since it may be necessary to leave the site open 24 hours per day to accommodate private industrial haulers and there is only need for one operating crew, it is suggested that each day cell be closed at such a time as to permit complete compaction and cover before the crew leaves each day. Private haulers which enter the site after this time would then be directed to start a new cell which would be closed at the end of operations the following day.

(b) Burning

The burning of refuse should not be allowed at a sanitary landfill site. Burning adversely affects public acceptance due to odours, air pollution, fire and safety hazards.

(c) Liquid Wastes

Sewage and industrial liquid wastes should not be accepted at a refuse sanitary landfill site. These liquids create health and safety hazards dangerous to the public and landfill employees as well as greatly increase the rate of decomposition and gas production.

(d) Limited Access

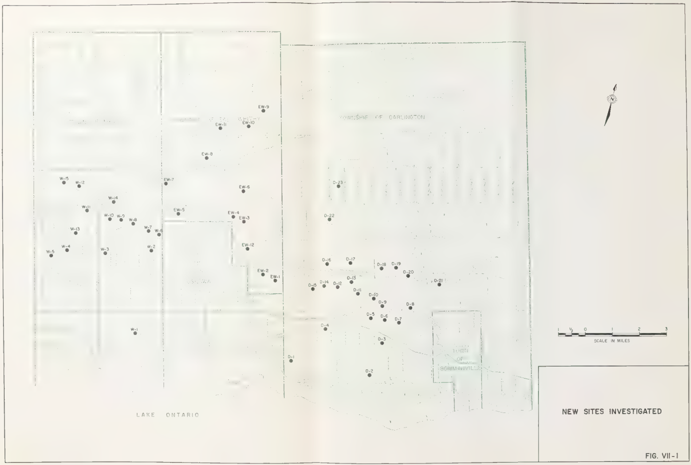
As it is the intent of this study that private individuals as well as the private and municipal collection agencies will be using the landfill site, access to the site should be limited to the times when there is an attendant on duty. As stated previously this would be 24 hours a day 6 days a week. To avoid congestion at the dumping face during operating hours private cars and small trucks should be allocated to a special area of the site.

(e) Salvage

Salvaging or scavenging should not be permitted at a sanitary landfill site. Salvaging at a disposal site delays the landfill operation and often results in the accumulation of unsightly refuse piles. Scavenging is an unhealthy and objectionable practice that interferes with the orderly and efficient operation of a landfill.

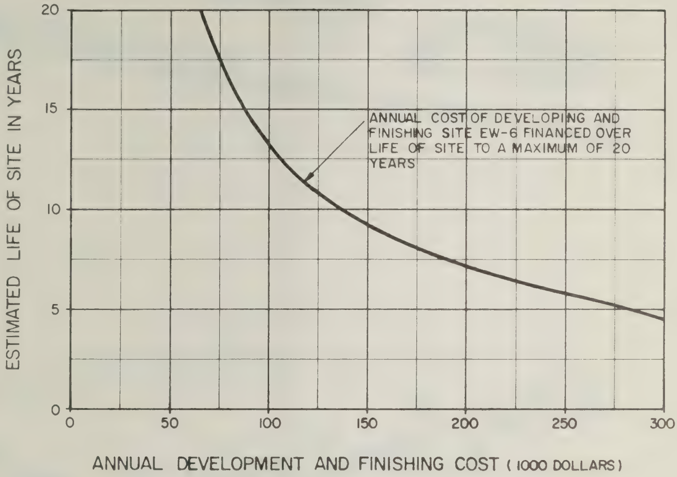
(f) Public Relations

The importance of achieving public acceptance of a sanitary landfill scheme cannot be over-emphasized. The term "sanitary landfill" is still used inter-changeably by the public and press with "landfill" and "dump". A public relations programme should emphasize the improvements in methods and procedures of refuse disposal. Good public relations are best secured by doing an outstanding job of refuse disposal. This can be achieved by providing first-class facilities and dependable operations.



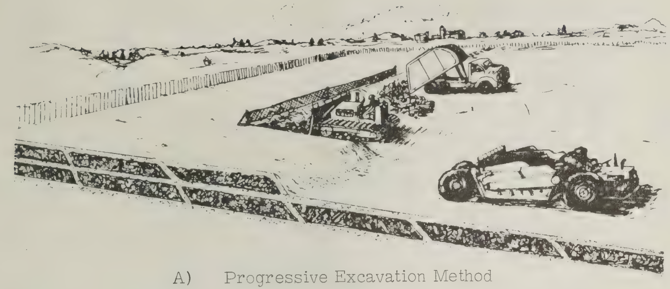
NEW SITES INVESTIGATED

FIG. VII-1

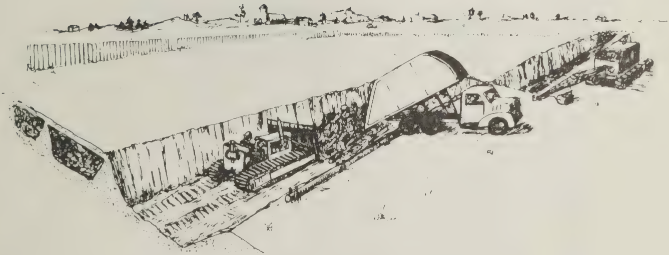


ANNUAL COST OF
DEVELOPING AND FINISHING
LANDFILL SITE EW-6

FIG. VII-2



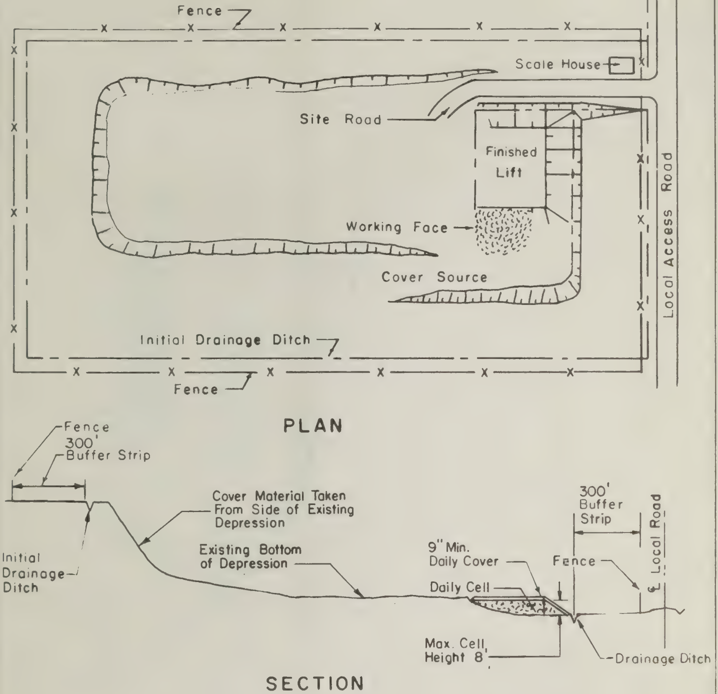
A) Progressive Excavation Method



B) Trench Excavation Method

AREA TYPE OF SANITARY LANDFILL

FIG. VII-3

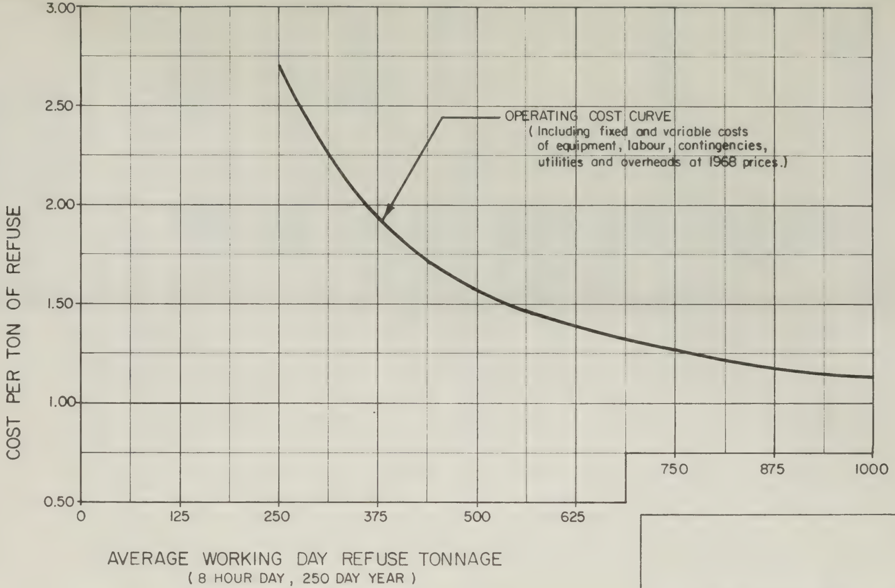


PLAN

SECTION

DEPRESSION TYPE METHOD OF SANITARY LANDFILL OPERATION

FIG. VII - 4



OPERATING COST CURVE

FIG. VII-5

TABLE VII-1

SITE SCORING SYSTEM FOR PROPOSED SANITARY LANDFILL SITES

General Objectives of Sanitary Landfill	Rating by Order of Importance	Site Characteristics and Considerations	Max. Possible Score for Site Characteristic and Consideration	LANDFILL SITES INVESTIGATED AND RATED																			
				0–1 (Ritson Rd.)	W-2	W-4	W-7	W-9	W-11	W-12	W-15	EW-5	EW-6	EW-7	EW-10	EW-11	EW-12	D-1	D-11 12 & 13	D-14	D-15	D-17	D-21
① TO AVOID JEOPARDY TO PUBLIC HEALTH AND SAFETY	1000	Ground Water Pollution Hazard	294.4	88.3	294.4	294.4	294.4	176.6	294.4	294.4	294.4	88.3	294.4	176.6	294.4	294.4	235.5	294.4	176.6	235.5	147.2	294.4	176.6
		Danger from Gas Travel	250.0	75.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
		Ground Water Pollution Potential	235.0	235.0	117.5	141.0	117.5	117.5	188.0	235.0	235.0	117.5	235.0	117.5	235.0	235.0	235.0	235.0	117.5	117.5	117.5	117.5	117.5
		Surface Water Pollution Potential	176.5	35.3	176.5	123.6	141.2	176.5	176.5	105.9	105.9	123.6	88.3	105.9	88.3	176.5	88.3	176.5	176.5	176.5	105.9	105.9	70.6
		Isolation from Odour and Dust	29.4	5.9	29.4	29.4	29.4	29.4	29.4	29.4	29.4	14.7	29.4	20.6	29.4	29.4	8.8	29.4	29.4	29.4	29.4	29.4	29.4
		General Access by Traffic	14.7	14.7	14.7	14.7	14.7	14.7	4.4	5.9	13.2	14.7	14.7	10.3	10.3	10.3	14.7	14.7	8.8	8.8	8.8	4.4	14.7
			1000.0	454.2	882.5	853.1	847.2	764.7	942.7	920.6	927.9	608.8	911.8	680.9	907.4	995.6	832.3	1000.0	758.8	817.7	658.8	801.6	658.8
② TO BE ACCEPTABLE TO THE PUBLIC	900	Isolation from Sight	246.4	49.2	123.2	123.2	246.4	246.4	246.4	123.2	73.9	98.6	148.0	73.9	246.4	221.8	73.9	98.6	246.4	246.4	246.4	246.4	98.6
		General Access by Traffic	209.7	209.7	209.7	125.8	209.7	209.7	62.9	62.9	167.8	125.8	209.6	104.9	125.8	125.8	209.7	209.7	125.8	125.8	125.8	62.9	209.7
		Isolation from Odour and Dust	148.0	118.4	148	148	148	148	148	148	148	74	148	74	148	148	44.4	148	148	148	148	148	88.8
		Isolation from Noise	148.0	148	148	148	148	148	148	148	148	74	148	118.4	148	148	74	148	148	148	148	148	148
		Surface Water Pollution Potential	98.6	19.7	98.6	69	78.9	98.6	98.6	59.2	59.2	69	49.3	59.2	49.3	98.6	49.3	98.6	98.6	98.6	59.2	59.2	39.4
		Desirability of Future Land Use as Completed Landfill	37.0	29.6	25.9	37	3.7	3.7	3.7	37	25.9	29.6	33.3	33.3	22.2	22.2	29.6	18.5	18.5	22.2	22.2	18.5	25.9
		Desirability of Improved Land Use	12.3	12.3	6.2	1.2	1.2	1.2	1.2	12.3	12.3	12.3	1.2	1.2	1.2	1.2	6.2	1.2	6.2	1.2	1.2	1.2	6.2
			900.0	586.9	759.6	652.2	835.9	855.6	708.8	590.6	635.1	483.3	737.4	464.9	740.9	765.6	487.1	722.6	791.5	790.2	750.8	684.2	616.6
③ TO RESULT IN IMPROVED LAND USE	600	Desirability of Future Land Use as Completed Landfill	462.0	369.6	323.4	462	46.2	46.2	46.2	462	323.4	369.6	415.8	415.8	277.2	277.2	369.6	231	231	277.2	277.2	231	323.4
		Desirability of Improved Land Use	138.0	138	69	13.8	13.8	13.8	13.8	138	138	138	13.8	13.8	13.8	13.8	69	13.8	69	13.8	13.8	13.8	69
			600.0	507.6	392.4	475.8	60	60	60	600	461.4	507.6	429.6	429.6	291	291	438.6	244.8	300	291	291	244.8	392.4
④ TO HAVE SIGNIFICANT LIFE IN REFUSE DISPOSAL SYSTEM	500	Life of Site Based on all Refuse to One Site	435.0	261	261	261	261	261	261	0	261	261	435	261	261	261	0	348	435	261	348	261	261
		Type of Site	65.0	13	52	52	52	52	52	65	65	52	65	52	65	52	65	65	52	52	52	52	52
			500.0	274	313	313	313	313	313	65	326	313	500	313	326	313	65	413	487	313	400	313	313
⑤ TO DISPOSE OF ALL TYPES OF REFUSE	300	Ground Water Pollution Potential	231.0	231	115.5	138.6	115.5	115.5	184.8	231	231	115.5	231	115.5	231	231	231	115.5	115.5	115.5	115.5	115.5	115.5
		Danger from Gas Travel	69.0	20.8	69	69	69	69	69	▨	69	69	69	69	69	69	69	69	69	69	▨	69	69
			300.0	251.8	184.5	207.6	184.5	184.5	253.8	300	300	184.5	300	184.5	300	300	300	184.5	184.5	184.5	184.5	184.5	184.5
⑥ TO BE CAPABLE OF PROPER DEVELOPMENT, OPERATION AND FINISHING	300	Site Able to be Dewatered if Desired	200.0	160.0	160.0	160.0	160.0	160.0	160.0	200.0	200.0	160.0	160.0	160.0	200.0	200.0	200.0	160.0	160.0	160.0	160.0	160.0	160.0
		Local Access by Traffic	100.0	100.0	100.0	20.0	80.0	80.0	30.0	80.0	80.0	100.0	100.0	50.0	70.0	80.0	100.0	100.0	50.0	50.0	50.0	30.0	80.0
			300.0	260	260	180	240	240	190	280	280	260	260.0	210	270	280	300	260	210	210	210	190	240
		TOTAL SCORE ATTAINED BY SITE		2334.5	2792.0	2681.7	2480.6	2417.8	2468.3	2756.2	2930.4	2357.2	3138.8	2282.9	2835.3	2945.2	2423.0	2824.9	2731.8	2606.4	2495.1	2418.1	2405.3
		POSITION ATTAINED BY SITE		⑲	⑥	⑨	⑫	⑯	⑬	⑦	③	⑱	①	⑳	④	②	⑭	⑤	⑧	⑩	⑪	⑮	⑰

GENERAL NOTES

1) The maximum score attainable for any site, based on total of six general objectives is 3600.

2) The following sites were rejected because of high ground water pollution potential: W-5, W-10, EW-1, D-2, D-3, D-6, D-7, D-9, D-10, D-18, and D-19.

3) Site D-20 was rejected because of high surface water pollution potential.

4) The following sites were rejected because of very small refuse capacity: W-1, W-3, W-6, W-8, W-13, W-14, EW-2, EW-3, EW-4, EW-8, EW-9, D-4, D-5, D-8, D-16, D-22.

5) Site D-23 was rejected because of poor access by traffic.

TABLE VII-2

Summary of Developing and Finishing Costs for Sites Studied in Detail

Site Number	Refuse Capacity Million Tons	Land Area Acres	Capital Cost of Developing $	Capital Cost of Finishing $	Total Cost
D-1	1.26	181	600,000	487,000	1,087,000
D-11, 12, 13	4.08	520	2,185,000	2,375,000	4,560,000
D-14	1.30	205	690,000	760,000	1,450,000
EW-6	2.40	190	465,000	963,000	1,428,000
EW-10	1.33	162	412,000	652,000	1,064,000
EW-11	0.71	132	360,000	793,000	1,153,000
W-2	0.69	127	494,000	441,000	935,000
W-4	0.70	132	396,000	434,000	830,000
W-12	0.63	113	193,000	419,000	612,000

NOTE: For location of sites see Fig. VII-1.

CHAPTER VIII

REFUSE INCINERATION

A. GENERAL

It is the intention in this chapter to review the various systems for refuse incineration in plants of a size (750 tons per day and below) pertinent for the Planning Area; and to estimate capital and operating costs associated with various installations.

Two general situations are envisaged. One includes the provision of incinerators for each urban municipality and the other the provision of one incinerator to serve basically the whole of the Planning Area.

Refuse incineration is the volumetric reduction of combustible waste by high temperature burning. The resulting residue, being 10 to 20% of the original refuse by volume, is relatively inert compared to raw refuse and can be disposed of by landfill with little nuisance or necessity for cover to maintain sanitary conditions. In addition there is a further portion of refuse collected in an area such as the Planning Area which is non-incinerable. This portion of the refuse (about 15% by weight) is too bulky to be inserted in conventional incinerators and normal practice is to provide sanitary landfill space for such refuse.

Possible advantages of incineration include: small land requirement, central location and short refuse haul, relatively inert and nuisance-free end-product suitable for reclaiming marginal land and constructing stable landfills, and the possibility of revenue to offset partially the cost of incineration through metal salvage and waste heat recovery.

Disadvantages of incineration include: relatively high investment and operating costs; not a complete disposal method as residue must be disposed of by other means; and potential nuisances from truck traffic and air pollution if plant is not properly located, designed and operated.

B. SPECIAL INCINERATORS

There are a number and variety of types of incinerators now being used in the Planning Area or which may be contemplated for use. They are used for the following purposes:

(a) apartment house incinerators

(b) industrial incinerators

(c) municipal refuse incinerators

(a) Apartment house incinerators: Incineration of refuse has long been an attractive alternative to proprietors of apartment houses. The main advantage of such installations has been a significant reduction in the volume of material to be stored and handled for disposal. Indirect disadvantages have resulted from various complaints usually as a result of nuisance caused by air pollution. The increased severity of air pollution control regulations have caused apartment house incinerator hardware to become more sophisticated and thus more expensive. This trend can be expected to continue. The development of relatively inexpensive bulk handling and containerization equipment has provided a viable alternative for handling apartment house refuse and the use of such systems can be expected to increase.

(b) Individual incinerators: Incineration of industrial refuse is practised to some extent in the Planning Area by individual industries. Often the particular industry has special disposal problems or some other use for the incinerator not directly related to the general reduction in volume of refuse. These include the burning of rubber from steel castings and the disposal of imported straw. The disadvantages of such installations are comparable to the disadvantages of apartment house incinerators and their use can also be expected to decrease as other dependable methods of disposal are made available in the area.

(c) Municipal incinerators: A variety of types of incinerators have been used with varying degrees of success and acceptability to reduce the volume of municipal refuse. The degree of sophistication has varied from installations which are scant improvements over open dump burning to installations which are comparable to other large modern installations of complex mechanical equipment with little or no resultant environmental disruptions.

Two types of incinerators which are in use in the area or nearby are the "trench" incinerator and the "teepee" incinerator. The Ajax incinerator is "trench" type built in a large abandoned septic tank. The tank has been converted to a combustion chamber with air nozzles directed from above and through the side fed by a heavy-duty centrifugal fan. There is a marked improvement in burning characteristics when the air system is operating. The cost of such an installation is minimal. The "teepee" type incinerator has, in the past, been used quite extensively. It is a conical metal structure with an opening at the top. It is also a low cost installation. Air pollution from such incinerators is such that it is improbable that the Air Pollution Control Service of the Provincial Government will permit the construction of either "trench" or "teepee" incinerators under the provisions of Regulation 449-67.

Thus the types of refuse incinerators considered for application in the Planning Area are restricted to those which from existing practice are known to be capable of meeting Air Pollution Control requirements.

C. INCINERATOR SYSTEM CONSIDERATIONS

1. Location of Incinerating Plants

Considering only disposal costs, the most economical plan for disposal by incineration would be the construction of a single large plant sized to handle all refuse from the Planning Area. This plant would probably be centrally located near Lake Ontario in the Oshawa area, and residue could be used for land filling.

An alternative plan for disposal by incineration of the refuse generated in the large Planning Area would involve the construction of several incinerator plants strategically located to achieve low haul costs and create minimum disruption to the business community and private citizens.

2. Land Use

Refuse incineration is similar to an industrial operation and, as a general policy, an incinerator plant should be located in an industrial zone or an isolated rural area. A properly designed and operated incinerator plant will cause no more nuisance than many types of light industry. Truck traffic is frequently the principal nuisance associated with incineration plants.

As stated previously, the incinerator residue must be disposed of by landfilling. Operating costs can be reduced somewhat if the residue landfill is located on the same site or near the incinerator plant. While a minimum of 5 acres are needed for a suitable plant in an urban setting with off-site disposal, more acreage is required for a rural setting with an on-site residue landfill.

On-site residue disposal plant sites should be preferably large enough to accommodate all plant residue and some non-incinerable material for twenty years. Such a site would normally be large enough to provide reasonable isolation thus minimizing the possibility of nuisance and public opposition. The residue landfill area should be screened from public view by the use of shrub or tree plantings.

3. Accessibility and Haul Distance

To minimize haul costs, incinerator plants should be located as near as possible to the centre of refuse production and be accessible via high-speed haul routes. Local haul routes should be designed for truck traffic. The nuisance of truck traffic can be minimized by locating the plant where such traffic is common and therefore not objectionable. In some cases, construction of special access roads may be justified.

Where off-site disposal of residue is appropriate, suitable haul routes must be available for the ash trucks.

4. Land Cost

Land cost will vary for different sites but the site selection should not be completely governed by land cost. A good site, properly located with respect to the collection area served and for residue disposal operations, might cost considerably more to purchase and still be of more value than a site not having these advantages. The site topography will also affect the cost of large continuous-feed plants due to the essentially sloping characteristic of the incineration process from feed to discharge.

Actual land costs cannot be determined until specific sites are selected; however, for purposes of economic analysis, an average cost of $10,000 per acre for an incinerator plant site is assumed.

5. Site Development and Structures

Each site would receive individual treatment suitable for the area and the development would include landscaping and security provisions. The road layout would be arranged for easy, non-congested movement of all vehicles (including residue trucks), and would accommodate an appropriate number of collection trucks waiting to be weighed without disrupting normal traffic on public thoroughfares adjacent to the site. All plant roads and parking areas would be paved and suitably drained. For large 24-hour per day operating plants, an adequate yard lighting system would be included.

Level sites would involve elevated tipping floors and sloping sites would utilize grade level tipping floors.

Plant structures would be of durable construction with extensive use of concrete and masonry units. Window area would be held to a minimum. Major structure design objectives would be good appearance, minimum maintenance, ease of operation and reasonable initial cost.

D. INCINERATOR PLANT CONSIDERATIONS

1. General

The incinerator plant provides for dumping, storing, handling and incinerating of refuse; and the subsequent removal of residue.

2. Dumping

All trucks would be weighed on a platform scale prior to entering the tipping floor area of the building. The scales would be of the mechanical platform type with dial located inside the building. This permits multi-purpose utilization of operating personnel. Mechanical print-out facilities showing net weight of refuse on the collector truck are justified for systematic recording of input.

3. Storing

It is appropriate to omit conventional refuse storage pits for small incinerating plants 100 TPD and below, having an 8-hour per day operating period. Instead refuse is stored on the charging floor and pushed directly into the furnace charging doors by small dozers or equivalent machines. This method has been utilized successfully in other locations and features economy of capital cost (no storage pits or cranes), simplicity of operation, and easy extraction of non-incinarable metal objects. The main disadvantage is lack of effective storage which is not too serious for relatively small quantities of refuse.

4. Operating Schedule

All plants in the capacity range under study are suitable for 5-day per week operation. This is preferred to 7-day operation often used for large plants (750 TPD and above) because the weekend leaves some incinerating capability "in hand" by extended operation. Also, the shifts of operating personnel are much more regular and easier to schedule.

Small plants 100 TPD and below are suitable for a one-shift 8 hour operating schedule. Generally, this means 8 hours effective time as warm up time in the morning (about one hour) is compensated by incinerator operation through lunch hour by reduced staff. Shut-down in the evening is relatively fast and can be carried out by a few men.

In certain cases, a two-shift 16 hour operating schedule can be justified. This applies to plants in the range of 125 to 250 TPD where batch-feed furnaces are utilized.

Larger plants 300 TPD and above are operated on a three-shift 24-hour basis in order to maximize the utilization of large equipment and to minimize the number of shut-downs to once per week. This tends to extend the life of the equipment, particularly incinerators of the continuous feed type.

5. Types of Incinerators

The types of incinerators for refuse disposal are many and varied. However, it is felt that the alternatives which are considered to be practical for 50 to 750 TPD plants may be listed as follows:

- Mechanically stoked or rocking grate refractory incinerators of packaged design suitable for batch-feed and direct residue dumping. This generally applies to incinerator ratings of 150 TPD and below.

- Moving grate refractory incinerators of special design suitable for continuous feed and continuous residue removal. This often applies to incinerator ratings of 200 TPD and above.

The use of steam generating incinerators reflecting European practice is not practical for the sizes under consideration. Excessive capital cost and operating complexity out weigh the possible advantages of this type of incinerator.

6. Description of Batch Feed Incinerators

(b) Mechanically-stoked and rocking grate type

The "Nichols" Monohearth incinerator is a typical mechanically-stoked batch-feed unit. This is available in unit ratings from 50 to 150 TPD and sometimes higher. Specific rating is a function of the heat content of the refuse which has been increasing markedly in recent years. It is of note that historically, this type of incinerator has been used across Canada in a great many installations including Winnipeg, Port Arthur, Toronto and Halifax.

Most units are of the circular type which utilizes powered rabble arms to spread the refuse on hinged grates which are dumped after burn out. Underfire air is from fans (or rarely used louvres), and overfire air is from open louvres (or rarely used fans). Combustion is completed in a combustion chamber before the hot gases pass on to scrubber and stack. Refuse feeding is done on a batch basis through a powered charging gate of heavy, rugged construction. After burnout, the ash residue is manually dumped from the grates to a hopper and eventually discharged through a bottom door into a truck.

The monohearth units are available in circular or square configurations. The circular layout is preferred because the shape permits the refractory to "grow" easily on warm-up to incinerating temperatures. The square layout using rocking grates is often used for maximum capacity in minimum space, however refractory maintenance is higher.

Grate loading for this type of incinerator is usually 60-75 lb. of refuse per hour per sq. ft. of effective area.

Batch feed incinerators require operating personnel at the charging floor (input), operating floor (incineration) and bottom floor (ash removal). Intercommunication between floors is by flashing lights and sounding gongs.

(b) Combustikator Package

A particular type of small batch-feed incinerator is a rectangular furnace with moveable grates of the type manufactured by "Combustion

Engineering". The Combustikator System is furnished as a package unit for single units of 72 tons per day rating. Moveable grates are powered by hydraulic or electric drive, and the rate of refuse travel along the grate can be selectively controlled. The ash dumping grates at the end of the grates are power operated to dump ash directly onto an ash discharge conveyor.

(c) In-Line Package

This is a modified batch-feed, continuous flow type of refractory furnace with ram feeder, travelling grates, wet (water impounding) bottom, continuous residue removal, integral scrubber, and induced draft fan. It is furnished as a package in the range of 50 to 125 TPD by such groups as "Affiliated Engineering Corp." and "Gray-American Incinerator Corp."

(d) Continuous-Feed Type

Reference is made to Section 9 for a discussion of this class of incinerator which is suitable for greater capacities.

7. Selection of Alternative Plants for Multiple Installations

Reference is made to Table VIII-1 showing incinerator plant selections for varying quantities of refuse to be burned in the range of 50 to 400 tons per day. Such plants, being representative only, are intended to indicate situations where more than one plant would be used to service the Planning Area.

The following criteria have been used in establishing the various plants:

(a) Plants 100 TPD and below (quantity to be incinerated) are of the direct feed type with no storage, and the operating period is 8 hours. Considerable economy of fixed cost is realized and simplicity of operation is featured. The time of operation coincides with time of refuse delivery by truck, and there should be only small amounts of refuse stored on the floor.

(b) Plants 200 to 400 TPD are of the "bin and crane" type having at least 1-1/2 days storage for 5-day operation. Operating period is extended to 16 or 24 hours. The extra cost of storage bins and cranes is offset by lower unit furnace costs because of greater utilization.

(c) Furnaces 150 TPD and below are of the batch feed type with direct residue dumping. This represents the best balance between fixed and operating costs, and avoids the complexities of continuous feed and continuous residue removal systems.

(d) Furnaces 200 to 300 TPD are of the continuous feed type with direct residue dumping. At this capacity, the complexity and expense of continuous feeding systems are justified by a reduction in total operating staff. (Plants utilizing three or more furnaces should employ continuous residue removal).

(e) Furnaces above 300 TPD are of the continuous feed type with continuous residue removal.

8. Selection of Single Plant for Entire Planning Area

(a) The following tabulation summarizes the average quantities of refuse which are anticipated from the Planning Area. It is to be noted that a quantity (approximately 15%) of the generated refuse is assumed as non-incinerable refuse. This refuse would be comprised mainly of items too large to be fed into the incinerators or which may be damaging to the incinerator mechanism.

	Tons/Year		Daily Tonnages			
			365 day Basis		250 day Basis	
Year	Generated	Incinerated	Gen.	Burned	Gen.	Burned
1968	99,700	84,750	273	232	399	339
1971	115,579	98,242	317	269	462	393
1976	144,009	122,408	395	336	576	490
1981	176,066	149,656	482	408	704	598
1986	213,990	181,892	586	498	856	728

(b) Quantity of refuse to be incinerated: Reference is made to Fig. VIII-1 showing average daily quantities to be incinerated (250 days per year basis) in the time period under consideration. Also, the maximum and minimum quantities shown are taken to be 1.2 x avg. and 0.7 x avg. respectively. Characteristically, generation of refuse is relatively high in spring and fall seasons and relatively low in winter and summer.

(c) Selection of Incinerators

Fig. VIII-I shows incineration capability vs. Planning Area requirement for the single plant site. Unit incinerator capacity is taken to be 110% of rating for maximum and 60% of rating for minimum (below which temperatures would drop and odours could occur). The intersection of the requirement and capability lines indicates the operating condition obtaining. The incinerator plan identified as being optimum for the Planning Area is given as follows:

Plan 2A: Three 265 TPD units installed, 24 hour, 5 day operating schedule.

Two in operation from 1970 to 1976

Three in operation from 1976 to 1986

The switch from two to three unit operation can be made in 1975 to 1977 when the ability of two furnaces at overload capacity can just meet the maximum quantity generated. In the initial period, the third unit is available for standby whenever a furnace is out for extended maintenance. Accordingly, an "Availability Factor" of 1 can be taken. In the final operating period, it is evident that three incinerators at overload capacity can meet the maximum quantity generated in 1986. Also, three incinerators at rating capacity are about 10% above average quantity generated, so that an Availability Factor of 1 can be used.

The recommended plant has relatively high fixed costs because of larger equipment but relatively low operating costs. A feature is that the larger equipment provides adequate standby during the life of the plant, which is highly desirable.

For plants of larger size operating on 16 or 24 hours per day schedule, conventional storage of refuse in large pits is justified together with incinerator charging by heavy-duty cranes. Experience indicates that this is the most practical method for storing and handling large quantities of refuse. Trucks would enter the tipping floors at one end and exit at the other, providing a smooth traffic flow. The enclosed tipping floors and storage pits would be sized to suit the individual plant capacities, and would provide an appropriate storage cushion for cyclic unloading of refuse from collection trucks and ensure a supply of refuse for non-interrupted incinerator operation. In general, a storage volume sufficient to provide for 1 1/2 days of refuse generation is appropriate for plants operating 5-days per week. The pits would be of reinforced concrete construction with armor rails embedded in the surfaces subject to grapple impact. The rear wall would have a bevel at the charging chutes to minimize cleaning requirements.

9. Description of Continuous Feed Incinerators and Auxiliaries for the Single Plant

a) General

The units selected for the single plant constitute high temperature incinerators with refractory lined furnaces and automatic stoking equipment. The stoking equipment, based on current North American practice, would be of the multiple travelling grate, rocking or reciprocating type to achieve necessary mixing and agitation with rated capacity based on a grate loading of approximately 60 lb. of refuse /hr. /sq. ft. In order to achieve this burning rate continuously, it is necessary to achieve essentially steady state conditions inside the furnaces. This cannot be accomplished with intermittent refuse feeding and its associated draft and temperature fluctuations. A continuous refuse feed from self-sealing chutes onto a drying grate is considered necessary to achieve steady state burning conditions in the furnaces.

Refuse would be fed onto the drying grates through a water-cooled feed chute to minimize the possibility of burning in the chute. The feed chutes would be connected to the charging hoppers with suitable metal expansion joints. Water flow for cooling these chutes would be automatically controlled to maintain adequate temperature to prevent condensation and corrosion of the chute surfaces in contact with the refuse. Burning refuse would be conveyed through the furnace by the action of the grates and the residue would drop into bifurcated chutes at the ends of the furnaces.

Combustion air would be supplied through the grates by air foil type forced draft fans. Overfire air would be supplied through furnace roof and wall ports as required for complete combustion and furnace temperature control by a separate fan of the air foil type. Forced draft and overfire air fans would be equipped with adjustable inlet vanes with control drives to permit remote variation of the air flow as required to achieve the most efficient combustion.

b) Induced Draft Equipment

Furnace draft control is essential to maintenance of good combustion conditions inside the furnaces. Natural draft designs are subject to poor control because of varying flue gas temperatures and volumes and to atmospheric conditions. Induced draft designs will furnish essentially constant furnace draft under the widely varying combustion conditions experienced in a refuse incinerator plant.

A separate induced draft fan would be installed for each continuous feed incinerator unit so that failure or maintenance of either component would not effect the other incinerators.

Fans would have radially tipped blades and constant speed motors. Furnace draft would be controlled automatically by inlet dampers. Depending on final plant arrangements, the fans may be located outside the main building.

c) Instruments and Control Equipment

Indicating and recording instruments, annunciators and remote control sub-panels would be grouped on a separate panel for each incinerator unit. Stack smoke density indicators for each stack and system draft gauges would be mounted on the panels.

Multiple point recorders would show furnace, gas to cooling section, gas to scrubber, and stack gas temperatures. Remote control sub-panels would include features necessary to control underfire and overfire air quantities, stoker speed and furnace draft. Annunciator points would be as required by the final system design.

The basic control system would be pneumatic to insure safe shutdown in the event of power failure. The annunciator system would use a battery powered standby system for the same reason. The compressed air supply would be from dual motor driven reciprocating type air compressors with large vertical receivers.

Local pressure gauges, thermometers, flowmeters, sample connections and other devices would be installed as required for ease of operation and analysis of plant operations. Portable instruments for flue gas analysis and for checking instruments would be provided.

d) Refuse Handling Facilities

Refuse is transferred from storage pit to incinerator charging chute by means of special heavy-duty cranes. Such cranes would be of the bridge and trolley type equipped with air conditioned, full vision control cabs and tine type grapples of appropriate capacity. They would have "Joystick" control levers with static stepless a. c. control elements for ease of operation and maintenance. Full length maintenance catwalks would be provided. Hoisting and travel speeds would be suitable for rehandling and for charging all furnaces at rated capacity with one crane out of service.

The cranes would discharge refuse into steel hoppers located at the charging floor level. Removable covers would be provided for these hoppers. Hoistways from the charging floor to the ground level would be used to handle non-incinerable objects pulled from the charging hoppers.

e) Residue Handling Facilities

Because there are three incinerators to be serviced, two independent drag chain conveyors would be installed in the plant so that either conveyor could handle the residue from all three furnaces. The residue would be fed to either of the conveyors by use of a diversion gate in the bifurcated chutes at the end of each furnace. The horizontal conveyor sections below the bifurcated chutes would operate in water impounding steel tanks. At one end of the plant the conveyors would incline upwards and discharge in loading out hoppers. The hoppers would be located so that residue hauling trucks would be loaded directly with no additional handling. Each hopper would be equipped with power-driven discharge gates to facilitate changing trucks without shutting down the conveyor system. The entire conveyor system would be enclosed except for the truck loading area under the hoppers. Access platforms for ease of operation and maintenance would be provided.

f) Air Pollution Control Equipment

Modern practice and a growing public awareness about the seriousness of air pollution in urban areas dictate a requirement for air pollution control equipment of high efficiency to remove particulate matter from the gas stream.

This will require installation of gas cleaning equipment with an overall collection efficiency of 90 to 95 per cent, depending on the furnace and duct configuration, type of stoking equipment, height of stack, and other design considerations. To meet this requirement, the equipment design should be such that stack emissions of the order of 0.35 lb. particulate matter per 1,000 lb. flue gas (corrected to 50% excess air) should be achieved under design burning conditions.

It is of note that the above criterion is typical only, because the requirements of the Air Pollution Control Service of the Ontario Provincial Government are defined in other terms, namely:

1. Minimum concentration of particulate matter at point of contact with the ground. Accordingly not only gas scrubber efficiency but also dispersion aspects including stack height, efflux velocity, and so forth must be accounted for in the overall picture.
2. Minimum odour.
3. Minimum opacity

It is obvious that greater capital expenditures will be required in gas cleaning and dispersing plant in order to meet the more stringent requirements of the new regulatory agency.

Gas cleaning equipment may be identified in broad terms as electrostatic precipitators, mechanical separators, wet scrubbers, and bag filters. Of these, the most practical choice for high temperature incinerator gases is the wet scrubber. Excessive furnace gas temperatures requires that pre-cooling be provided for temperature control for electrostatic precipitators, bag filters and some types of wet scrubbers.

Wet scrubbers suitable for this application include the flooded orifice type similar to "Research - Cottrell" Flooded Disc Scrubber, and the baffled spray chamber (high efficiency design) similar to "Nichols" Wetscrub.

The flooded orifice unit tends to be very efficient but is sometimes susceptible to clogging and corrosion. Gases pass through multiple water baths and emerge completely saturated at 200°F. This requires a reheater to avoid plume evidence at low ambient temperatures and excessive moisture in the stack. The flooded orifice is well suited to continuous operation associated with continuous feed furnaces, and usually one scrubber is assigned to each furnace together with an induced draft fan.

The baffled spray chamber is a large refractory lined steel duct having inertial separation sections, multiple refractory impingement baffles, and wet (water impounding) bottom. Two scrubbers are often provided for a plant having two or more incinerators (generally batch-feed type), and induced draft equipment must be provided because of the pressure loss associated with multiple baffles required for high efficiency removal. Gases emerge from this device at about 600°F.

and up to 80% saturated. This class of scrubber has been utilized in many Canadian refuse plants.

Since scrubbers are quite large structures and have large connecting ducts, they would be located outside the building either on the roof or behind the plant, depending on the final layout. The ducts would be of alloy steel plate construction with refractory linings.

g) Water Reclamation

Considerable water will be used in the air pollution control system and a complete water reclaiming plant is justified for the situation involving one plant in the Planning Area. This system would include clarifiers and related equipment to separate the particulate solids from the scrubber slurry and return clarified water to the scrubber for re-use.

h) Stack

The single plant would be provided with a common stack of the free-standing masonry or concrete type with refractory lining. One stack would serve three incinerators, and its height would be at least 200 ft. for wide dispersion of the exit gas stream. A discharge nozzle could be provided to jet the gases to a higher elevation. This in conjunction with natural thermal rise will improve the dispersion effect.

i) Building Services

Preliminary concepts for the single plant include offices for plant and shift supervisors, locker room, lunchroom, small maintenance shop, and several storage rooms. Wash and shower facilities would be incorporated with the locker room. Adequate stairways and platforms for normal plant operation would be included in the building design.

Hot water heating throughout the plant would be provided from a package boiler; with air handling units, unit heaters and convectors as required in various areas. The use of waste heat boilers for plant heating only has not proved economically sound in most installations. Summer ventilation would be provided by large gravity openings and powered roof ventilators (outlet) and large wall louvres (inlet). The overfire air fans would also aid in ventilation.

The electrical installation would be based on a unit system concept so that failure of a single component would not take the entire plant out of service. Major loads would be served directly from 575 volt switchgear and smaller loads would be served from motor control centres or distribution panels located to suit the final plant arrangement.

All electrical cable would be heavy-duty with high temperature mineral insulation installed in cable trays where suitable. Flexible liquid-tight connections would be used for all motors and equipment. Emergency lights would be provided.

A simple plant intercommunication system with local handsets at various locations would be installed.

Satisfactory operation of a relatively large incinerator plant requires numerous plant services not directly associated with the incineration process. Determination of the extent of all such service systems is dependent on final plant design but the following list indicates principal equipment and systems included in the cost estimates presented later:-

Vacuum cleaning equipment
House service compressed air system
Laboratory equipment for checking water
  re-claiming system operation
Small machine shop with drill press,
  grinders, welding equipment and benches.
Fire extinguishers and cabinets and
  hose racks.
Instrument test equipment

j) Summary of Main Features

It is recommended that a single incinerator plant suitable for the Planning Area should incorporate the following features:-

1. Fully enclosed operating areas (including scale dial)
2. Substantial building with office and locker rooms.
3. Refuse pit large enough to permit five day-per-week operation; equivalent to at least 1 1/2 days refuse generation.

4. Three continuous feed refractory incinerators with moving grates, and a continuous residue removal system.

5. Overfire and underfire air fans.

6. High efficiency air pollution control equipment, together with induced draft fans and water reclamation equipment.

7. Stack approximately 200 feet high.

E. COST CONSIDERATIONS

1. General

North American practice varies considerably with respect to the sophistication of refuse incinerators but the recent and current trends are for continued improvements in all phases. This concept of continued improvement in all phases has resulted in increased initial cost for refuse incineration plants. These improvements reflect the more stringent standards now being imposed with regard to air and water pollution.

Because of the considerable difference in initial cost of current North American installations, an economic analysis requires the development of basic criteria, covering the above elements, necessary to meet all requirements of local laws and regulations and considered suitable for the agency responsible for refuse disposal facilities. Individual plant costs would vary somewhat for different plant sites but the costs presented later in this report are considered adequate to meet the needs of the Planning Area. Costs are presented in two groupings, the first for multiple plants (1A to 1E), and the second for a single plant (2A). Additional cost data is included showing the breakdowns for labour and utilities.

2. Cost of Incineration

The total cost of incineration is composed of the cost of ownership (fixed cost) associated with the capital investment, the cost of operating and maintaining the facility, and the cost of residue hauling and disposal.

(a) Capital Investment (Fixed Cost)

The cost estimates tabulated have been prepared and are based on equipment manufacturers' quotations. The cost of ownership will vary somewhat depending on the financing method used and the interest rate. For study purposes the financing is assumed to be 20-year debentures with an interest rate of 7.0 per cent. The actual annual payment required to fully amortize these debentures would be 9.4 per cent of the capital investment.

(b) Operation and Maintenance Cost

The annual operating cost is the total of plant labour cost (including overhead and fringe benefits), maintenance and supplies, and utility costs for running the plant.

The annual labour costs are shown in Section F-3, and are based on an average wage for the operating staff.

The annual maintenance and supplies cost are estimated to average ten per cent of the fixed charges throughout the life of the plant.

Utility cost shown in Section F-4 has been calculated for the estimated water and electric usage based on estimated rates for these utilities.

(c) Residue Hauling and Disposal Cost

The cost of resudie hauling and disposal have been calculated on the basis of a landfill disposal site located five miles from the incinerator plant and on a cost of 80 cents per ton refuse burned.

3. Cost Summary

(a) Unit costs have been developed for multiple plants. These are summarized as follows:-

Nominal Plant Capacity	Cost per Ton
50 TPD	$14.39
100 TPD	11.97
200 TPD	10.71
300 TPD	8.99
400 TPD	7.83

(b) Unit costs for the single plant have been developed as follows:-

Year	Average Quantity to be Burned	Cost per Ton
1976	490 TPD	$7.85
1986	728 TPD	$6.34

(c) With respect to the maximum capability of the above plant, three units could operate 7 days/week at an 80% Availability Factor, giving an annual throughput of 3 x 265 x 365 x 0.8 = 232,000 tons per year. Additional storage volume would have to be constructed to achieve the equivalent of at least 2 1/2 days generation. If incinerators were operated on this basis, an additional nine men would be needed (four shift operation) together with higher costs for utilities and residue disposal, resulting in a total annual cost of $1,320,000. Accordingly, the cost per ton would be $5.70.

F. COST ESTIMATES

1. Cost Estimates for Multiple Plants

(i) Cost Estimate 1A

Nominal Plant Capability	50 TPD
Number of Furnaces	Two
Unit Incinerator Rating	75 TPD
Operating Schedule	8 hours per day, 5 days per week
Availability Factor	1.00
Type of Plant	- Dozer Loading (no storage) - Batch Feed - Direct Residue Dump

Typical Furnaces* - "Nichols" Monohearth
- "Combustion Engineering Combustikator"

A. Capital Investment

Building and Site Development	$375,000
Mechanical Equipment	300,000
Electrical	45,000
Mechanical Building Services	30,000
Sub Total	$750,000*

* Note: Detailed costs are for Monohearth. Total capital cost is approximately the same for two Combustikator packages (72 TPD each) which are quoted at $550,000 without foundation, etc.

Engineering @ 8%	60,000
Land (5 Acres)	50,000
Total	$860,000
Annual Fixed Cost	$ 80,800

B. Operating and Maintenance Cost

Plant Labour	72,000
Utilities	9,500
Maintenance and Supplies	7,650
Annual "O&M" Cost	$ 89,150

C. Annual Residue Hauling and Disposal	10,000
TOTAL ANNUAL COST	$ 179,950
ANNUAL TONNAGE	12,500
COST PER TON	$14.39

(ii) Cost Estimate 1B

Nominal Plant Capability	100 TPD
Number of Furnaces	Two
Unit Incinerator Rating	150 TPD
Operating Schedule	8 hours per day, 5 days per week
Availability Factor	1.00
Type of Plant	- Direct Loading (no storage) - Batch Feed - Direct Residue Dump

Typical Furnaces - "Nichols" Monohearth
- "Detroit Stoker" Reciprocating Grate

A. Capital Investment	
Building and Site Development	$750,000
Mechanical Equipment	735,000
Electrical	99,000
Mechanical Building Services	66,000
Sub Total	$1,650,000
Engineering @ 8%	132,000
Land (5 Acres)	50,000
Total	$1,832,000
Annual Fixed Cost	172,200
B. Operating and Maintenance Cost	
Plant Labour	72,000
Utilities	18,985
Maintenance and Supplied	16,300
Annual "O&M" Cost	$107,285
C. Annual Residue Hauling and Disposal	$ 20,000
TOTAL ANNUAL COST	$299,485
ANNUAL TONNAGE	25,000
COST PER TON	$11.97

(iii) Cost Estimate 1C(i)

Nominal Plant Capability	200 TPD
Number of Furnaces	Two
Unit Incinerator Rating	150 TPD
Operating Schedule	16 hours per day, 5 days per week
Availability Factor	.9
Type of Plant	- Bin & Crane - Batch feed - Direct Residue Dump

Typical Furnaces - "Nichols" Monohearth
- "Detroit Stoker" Reciprocating Grate

A. Capital Investment

Building and Site Development	$ 976,000
Mechanical Equipment	711,500
Electrical	112,500
Mechanical Building Services	75,000
Sub Total	$1,875,000
Engineering @ 8%	150,000
Land (5 Acres)	50,000
Total	$2,075,000
Annual Fixed Cost	195,000

B. Operating and Maintenance Cost

Plant Labour	$ 192,000
Utilities	40,516
Maintenance and Supplies	18,450
Annual "O&M" Cost	$ 250,966

C. Annual Residue Hauling and Disposal	36,000
TOTAL ANNUAL COST	481,966
ANNUAL TONNAGE	45,000
COST PER TON	$10.71

(iv) Cost Estimate 1C (ii)

Nominal Plant Capability	200 TPD
Number of Furnaces	Two
Unit Incinerator Rating	100 TPD
Operating Schedule	24 hours per day, 5 days per week
Availability Factor	.9
Type of Plant	- Bin & Crane - Batch Feed - Direct Residue Dump

Typical Furnaces - "Nichols" Monohearth
- "Detroit Stoker" Reciprocating Grate

A. Capital Investment

Building and Site Development	$ 650,000
Mechanical Equipment	475,000
Electrical	75,000
Mechanical Building Services	50,000
Sub Total	$ 1,250,000
Engineering @ 8%	100,000
Land (5 Acres)	50,000
Total	$ 1,400,000
Annual Fixed Cost	131,600

B. Operating and Maintenance Cost

Plant Labour	276,000
Utilities	42,316
Maintenance and Supplies	12,450
Annual "O&M" Cost	330,766

C. Annual Residue Hauling and Disposal	$ 36,000
TOTAL ANNUAL COST	498,366
ANNUAL TONNAGE	45,000
COST PER TON	$11.07

(v) Cost Estimate 1D

Nominal Plant Capability	300 TPD
Number of Furnaces	Two
Unit Incinerator Rating	150 TPD
Operating Schedule	24 hours per day, 5 days per week
Availability Factor	.9
Type of Plant	- Bin & Crane - Batch Feed - Direct Residue Dump

Typical Furnaces - "Nichols" Monohearth
- "Detroit Stoker" Reciprocating Grate

A.	Capital Investment	
	Building and Site Development	$ 976,000
	Mechanical Equipment	711,500
	Electrical	112,500
	Mechanical Building Services	75,000
	Sub Total	$ 1,875,000
	Engineering @ 8%	150,000
	Land (5 Acres)	50,000
	Total	$ 2,075,000
	Annual Fixed Cost	195,000
B.	Operating and Maintenance Cost	
	Plant Labour	276,000
	Utilities	63,474
	Maintenance and Supplies	18,450
	Annual "O&M" Cost	357,924
C.	Annual Residue Hauling and Disposal	54,000
	TOTAL ANNUAL COST	606,924
	ANNUAL TONNAGE	67,500
	COST PER TON	$8.99

(vi) Cost Estimate 1E

Nominal Plant Capability	400 TPD
Number of Furnaces	Two
Unit Incinerator Rating	200 TPD
Operating Schedule	24 hours per day, 5 days per week
Availability Factor	.9
Type of Plant	- Bin & Crane - Continuous Feed - Direct Residue Dump

Typical Furnace - "Detroit Stoker" Moving Grate

A. Capital Investment

Building and Site Development	$1,240,000
Mechanical Equipment	920,000
Electrical	144,000
Mechanical Building Services	96,000
Sub Total	$2,400,000
Engineering @ 8%	192,000
Land (5 Acres)	50,000
Total	$2,642,000
Annual Fixed Cost	248,400

B. Operating and Maintenance Cost

Plant Labour	276,000
Utilities	84,930
Maintenance and Supplies	23,500
Annual "O&M" Cost	$ 384,430

C. Annual Residue Hauling and Disposal	72,000
TOTAL ANNUAL COST	704,830
ANNUAL TONNAGE	90,000
COST PER TON	$7.83

2. Cost Estimate for Single Plant

Cost Estimate 2A

Average Quantity to be Burned (1986)	- 182,000 Tons per year 728 TPD (250 days per year)
Number of Furnaces	- Three
Unit Incinerator Rating	- 265 TPD
Operating Schedule	- 24 hours per day, 5 days per week
Type of Plant	- Bin and Crane - Continuous Feed - Continuous residue removal

Typical Furnace: - "Detroit Stoker" reciprocating grate

A. Capital Investment

Building and Site Development	$2,000,000
Incinerator Units	875,000
Refuse Cranes	260,000
Gas cleaning equipment (incl. i.d. fans)	560,000
Stack	120,000
Scales	30,000
Electrical	282,000
Mechanical Building Services, Instruments, and Piping	450,000
Sub Total	$4,577,000

Engineering @ 8%	360, 000
Land (5 Acres)	50, 000
Total	$4, 987, 000
Annual Fixed Cost (9. 4%)	468, 800

B. Operating and Maintenance Cost

	(1)	(2)
Plant Labour	$276, 000	$384, 000
Utilities	86, 000	118, 940
Maintenance and Supplies	35, 000	43, 700
Annual "O&M" Cost	$397, 000	$546, 640

C. Annual Residue Hauling and Disposal	$ 98, 000	145, 600
TOTAL ANNUAL COST	$963, 800	$1, 151, 040
ANNUAL TONNAGE	122, 408	182, 000
COST PER TON	$7. 85	$6. 34

Notes: (1) Operate two units only from 1970 to 1976. (Third is standby).

(2) Operate three units from 1976 to 1986.

3. Plant Labour Estimates

(i) Plant Labour Requirements and Cost Estimates for 1A and 1B

Number of Incinerators — Two

Operating Schedule — 8 hours per day, 5 days per week

	Shift
Plant Supervisor	1
Stokers	2
Scaleman	1
Labourer	1
Maintenance Mechanic	1
	6

Direct Annual Labour Cost at 1968 Rates	$48, 000
Allowance for Overhead and Fringe Benefits (50%)	24, 000
Total Estimated Annual Labour Cost Based on 1968 Rates	$72, 000

(ii) Plant Labour Requirements and Cost for 1C(i)

Number of Incinerators	Two
Operating Schedule	16 hours Per Day, 5 Days Per Week

	Shift	
	First	Second
Plant Supervisor	1	-
Shift Supervisor	-	1
Stokers	2	2
Crane Operators	1	1
Charging Floor Attendant	1	1
Scaleman	1	-
Tipping Floor Attendant	1	-
Labourer	1	1
Maintenance Mechanic	1	-
Electrician	1	-
Total	10	6

Direct Annual Labour Cost at 1968 Rates	$128,000
Allowance for Overhead and Fringe Benefits (50%)	64,000
Total Estimated Annual Labour Cost Based on 1968 Rates	$192,000

(iii) Plant Labour Requirements and Cost for 1C(ii) 1D and 1E

Number of Incinerators	Two
Operating Schedule	24 Hours per Day, 5 Days Per Week

	Shifts		
	First	Second	Third
Plant Supervisor	1	-	-
Shift Supervisor	1	1	1
Stokers	2	2	2
Crane Operators	1	1	1
Charging Floor Attendant	1	1	1
Scaleman	1	-	-
Tipping Floor Attendant	1	-	-
Labourer	1	1	1
Maintenance Mechanic	1	-	-
Electrician	1	-	-
	11	6	6

Direct Annual Labour Cost at 1968 Rates	$184, 000
Allowance for Overhead and Fringe Benefits (50%)	92, 000
Total Estimated Annual Labour Cost Based on 1968 Rates	$276, 000

(iv) Plant Labour Requirements and Cost for Single Plant

Number of Incinerators	Three
Operating Schedule	24 Hours per Day, 5 Days per Week

	Shift		
	First	Second	Third
Plant Supervisor	1	-	-
Shift Supervisor	1	1	1
Incinerator Operators	1	1	1
Stokers	3	3	3
Crane Operators	1	1	1
Charging Floor Attendant	2	2	2
Scaleman	1	-	-
Tipping Floor Attendant	1	-	-
Labourer	1	1	1
Maintenance Mechanic	1	-	-
Electrician	1	-	-
Total	14	9	9

Basic Annual Labour Cost at 1968 Rates	$256, 000
Allowance for Overhead and Fringe Benefits (50%)	128, 000
Total Estimated Annual Labour Cost Based on 1968 Rates	$384, 000

Notes

1. For two incinerators operating and one standby, deduct $108, 000 for 3 operators, 3 stokers, and 3 charging floor attendants. Resultant total annual labour cost is $276, 000.
2. For three incinerators operating 7 days per week, 24 hours per day, add $130, 000 for the additional labour. Resulting total labour cost is $514, 000.

4. Utility Estimates

50 TON PER DAY PLANT (1A)

(i) Annual Water Usage = 16,900,000 gal.

Gross Cost @ $0.33 per 1000 gal.	$ 5,580
Sewer Service Charge (22.7%)	1,266
Gross Billing	$ 6,846
Prompt Payment Discount (10%)	- 685
Net Annual Water Cost	$ 6,161
Annual Electric Usage = 334,000 KWH Annual Electric Cost @ 1 cent/ KWH	3,340
Total	9,501

100 TON PER DAY PLANT (1B)

(ii) Annual Water Usage = 33,700,000 gal.

Gross Cost @ $0.33 per 1000 gal.	$11,120
Sewer Service Charge (22.7%)	2,530
Gross Billing	$13,650
Prompt Payment Discount (10%)	- 1,365
Net Annual Water Cost	$12,285
Annual Electric Usage = 670,000 KWH Annual Electric Cost @ 1 cent/KWH	6,700
Total	$18,985

200 TON PER DAY PLANT (1C(i) and 1C(ii)

(iii) Annual Water Usage = 67, 400, 000 gal.

Gross Cost @ $0. 33 per 1000 gal.	$22, 200
Sewer Service Charge (22. 7%)	5, 040
Gross Billing	27, 240
Prompt Payment Discount (10%)	- 2, 724
Net Annual Water Cost	$24, 516
Annual Electric Usage - 1, 780, 000 KWH Annual Electric Cost @ 1 cent/KWH	17, 800
Total	$42, 316*

* Deduct $1, 800 from the electric cost for the 16 hour per day operation. Total utility cost is $40, 516.

(iv)

300 TON PER DAY PLANT (1D)

Annual Water Usage = 101, 000, 000 gal.

Gross Cost @ $0. 33 per 1000 gal.	$33, 300
Sewer Service Charge (22. 7%)	7, 560
Gross Billing	$40, 860
Prompt Payment Discount (10%)	- 4, 086
Net Annual Water Cost	$36,774
Annual Electric Usage = 2, 670, 000 KWH Annual Electric Cost @ 1 cent/KWH	26, 700
Total Estimated Utility Cost	$63, 474

(v) 400 TON PER DAY PLANT (1E)

Annual Water Usage = 135, 000, 000 gal.	
Gross Cost @ $0. 33 per 1000 gal.	$44, 600
Sewer Service Charge (22. 7%)	10, 100
Gross Billing	$54, 700
Prompt Payment Discount (10%)	-5, 470
Net Annual Water Cost	$49, 230
Annual Electric Usage = 3, 570, 000 KWH	
Annual Electric Cost @ 1 cent/KWH	35, 700
Total Estimated Utility Cost	$84, 930

(vi) SINGLE PLANT (2A)

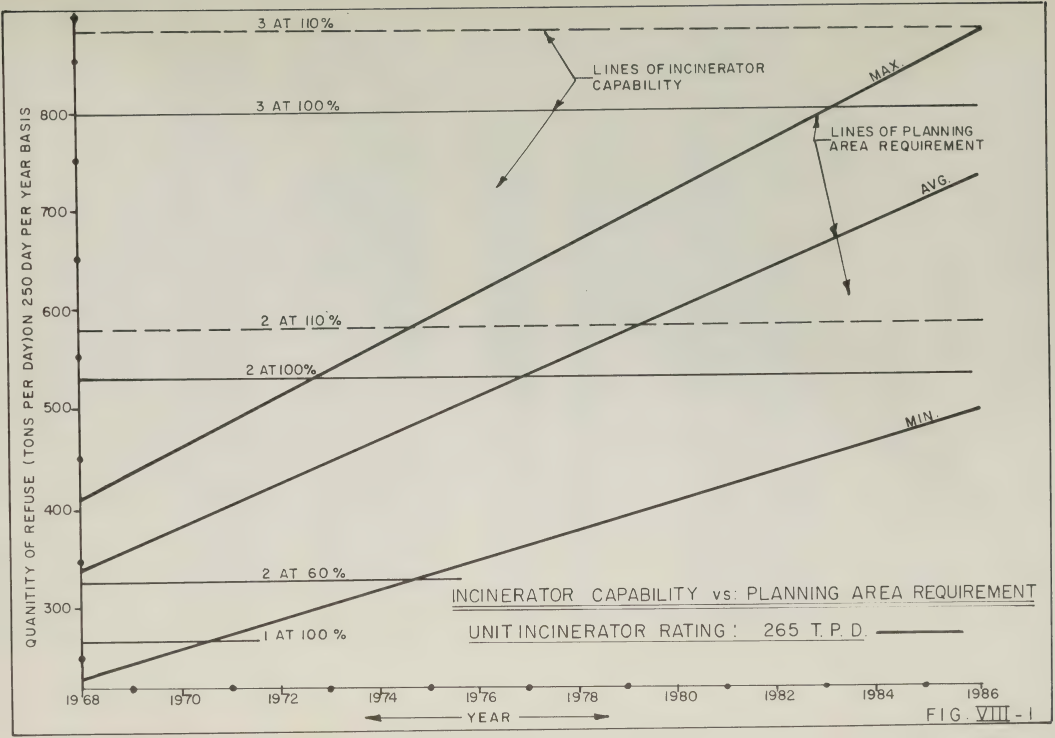
Annual Water Usage = 189, 000, 000 gal.	
Gross Cost @ $0. 33 per 1000 gal.	$62, 400
Sewer Service Charge (22. 7%)	14, 200
Gross Billing	76, 600
Prompt Payment Discount (10%)	-7, 660
Net Annual Water Cost	$68, 940
Annual Electric Usage = 5, 000, 000 KWH	
Annual Electric Cost @ 1 cent/KWH	50, 000
Total Estimated Utility Cost	$118, 940

TABLE VIII-I - SELECTION OF ALTERNATIVE PLANTS FOR MULTIPLE INSTALLATIONS

Nominal Plant Capability	Daily Operating Period	Req'd Plant Capacity (24-Hr Basis)	No. of Incin.	Unit Incin. Rating	Availability Factor (1)	Weekly Operating Period	Annual Capacity(2)	Type of Plant
1A 50 TPD	8 hrs	150 TPD	2	75 TPD	1.0	5 days	12,500 tons (3)	. Dozer loading (no storage) . Batch feed . Direct residue dump
1B 100 TPD	8 hrs	300 TPD	2	150 TPD	1.0	5 days	25,000 tons	. Dozer loading (no storage) . Batch feed . Direct residue dump
1C 200 TPD	16 hrs	300 TPD	2	150 TPD	0.9	5 days	45,000 tons	. Bin and Crane . Batch Feed . Direct residue dump
	24 hrs	200 TPD	2	100 TPD	0.9	5 days	45,000 tons	
1D 300 TPD	24 hrs	300 TPD	2	150 TPD	0.9	5 days	67,500 tons	. Bin and Crane . Batch Feed . Direct residue dump
1E 400 TPD	24 hrs	400 TPD	2	200 TPD	0.9	5 days	90,000 tons	. Bin and Crane . Continuous feed . Direct residue dump

Notes:

1. Availability Factor: This provides for maintenance outages on a long-term basis.
   - (a) For 8-hr. 5-day plants, (250 days per year) maintenance outage of one unit is handled completely by extended operation of the other on a short-term basis, either daily or weekly.
   - (b) For 24-hr/day 5-day plants, 50% of maintenance outage requirement is assumed to be handled by sixth day operation of the other on a short-term overloading basis. Adequate storage is required.
2. Annual capacity is for average quantities of refuse. Additional incinerator capacity or extended operation is required for peak quantities (1.2 x avg.).
3. Example calculation: 50 x 250 x 1.0 = 12,500 tons per year.



INCINERATOR CAPABILITY vs: PLANNING AREA REQUIREMENT

UNIT INCINERATOR RATING: 265 T.P.D. ——

FIG. VIII - I

CHAPTER IX

SPECIALIZED WASTES AND THEIR DISPOSAL

A. GENERAL

As previously noted, significant volumes of waste materials are generated daily from a variety of sources, over and above the "normal" refuse that is collected from residential, commercial and industrial areas. Among these wastes there is fly ash from steam-generating plants, foundry sand, demolition lumber and construction debris, dead and diseased trees, liquid industrial wastes, and seasonal wastes such as autumn leaves and Christmas trees. The possible disposal methods applicable to each of these wastes is discussed below.

B. FLY ASH AND BOTTOM ASH

The largest volume of ash produced in the Planning Area comes from the General Motors car and truck assembly plants in Oshawa.

Recent developments, concerning the utilization of fly-ash from H.E.P.C. thermal plants for the production of light weight precast concrete aggregate suggest that a market for this material may be developing in the area.

If fly ash is simply dumped into Lake Ontario, the finer particles would quickly float to the surface and form a grey scum. For this reason, the Ontario Water Resources Commission refused an application by Ontario Hydro to dump fly ash in the centre of the lake from bottom-dump barges. For this reason too, lakefront reclamation using fly ash is not feasible unless a dyke is constructed first to protect the fly ash fill from wave action. To date, landfill disposal of fly ash in low-lying areas and old gravel pits has proved to be the most economical method.

The fly ash should not be placed in the sites recommended for sanitary landfill as it is an uneconomical use of the space. Its use as cover material is not recommended because of its abrasive properties and susceptability to water erosion, however from discussions with the Oshawa Harbour Commission this waste might be used to advantage in landfilling programs in the harbour area.

C. FOUNDRY SAND

The manufacturing plants of Fittings Limited and Ontario Malleable Iron contribute the majority of the waste foundry sand in the study area. At present this material is used for land filling by a private hauler. The material is relatively inert and is suitable for filling below the water table, or for filling low areas around the lake. From discussions with the Oshawa Harbour Commission, it appears there may be some advantage gained from using this waste material in the Oshawa Harbour area.

D. DEMOLITION LUMBER AND DEBRIS

In recent years, the Golden Horseshoe Area of Ontario has witnessed some very extensive redevelopment, especially along the major arterial roads. Such redevelopment is often preceded by the demolition of older buildings, and this operation generates significant quantities of splintered lumber, old shingles, tar and gravel roofing, etc. It is interesting to note that most building materials, especially old bricks, piping and lumber from demolition work are salvaged and resold.

1. Disposal of Demolition Lumber

Landfill has proven to be the most economical disposal method for demolition lumber. Accordingly it is recommended that the demolition lumber and debris be disposed of in a sanitary landfill.

E. TREES

Each year, many trees are cut down in the Central Ontario Joint Planning Area. Many of them are large diseased elms but a significant number of healthy trees are also cut down to make way for street widening, local improvement and land development schemes. In most cases, the trunks are cut off near ground level and the roots are either left untouched or chipped out with special machines to a point some 6 to 12 inches below ground level. A small percentage of stumps and roots would also have to be dislodged and removed, notably in road widening or land development projects.

1. Disposal of Trees, Brush and Stumps

It is recommended that trees and stumps be disposed of in landfill sites in the same manner as demolition refuse. Brush and small limbs, however, should be chipped to help minimize operational costs and permit better compaction of the fill at the disposal site.

It should also be noted that immediate burial of diseased elms tends to halt the spread of Dutch Elm Disease by eliminating contact between the causal fungus and the bark-feeding beetles that carry the disease. The storage of elm logs, without de-barking or other pretreatment, in garages or backyards for use in household fireplaces on the other hand, can result in a spreading of the disease.

Special "bulky refuse incinerators" in Detroit and New Jersey have been built specifically for burning combustibles such as demolition lumber, trees, brush, old furniture, mattresses, etc. Unfortunately, the capital costs and operating costs for such an installation are substantially higher than the comparable landfill costs.

F. SEASONAL WASTES

Seasonal wastes include such items as leaves, Christmas trees and refuse from spring clean-up. In the three urban centres of the study area the small portion of these wastes which is municipally collected is disposed of in the existing disposal sites. The remainder of the refuse is hauled to the disposal site in private cars, trucks, trailers, etc.

In general, there is no reason to change from the practice of disposing of these wastes in a sanitary landfill.

G. LIQUID INDUSTRIAL WASTES

The liquid wastes generated by industries in the study area have been previously categorized as follows:

(a) inflammable wastes

(b) acidic wastes

(c) alkaline wastes

(d) miscellaneous wastes

1. Disposal of Inflammable Wastes

Special incinerators termed "fluidized bed incinerators" have been used in the petroleum, petrochemical, automobile and the pulp and paper industries for burning mixtures of inflammable and some relatively non-inflammable wastes. However, such units are costly and require skilled personnel to operate them. So far as can be determined, there are no municipal incinerators in North America which are operated exclusively for the burning of inflammable liquid wastes. Experience at large industrial complexes where various inflammable liquids are incinerated has revealed the following facts:

(a) the facilities required to incinerate inflammable liquids are costly to build and operate. Capital costs in the order of $200,000 to $500,000 are common for fluidized bed incinerators, depending on size and complexity.

(b) a thorough knowledge of the wastes' chemical makeup is vital in order to control incinerator temperatures and minimize hazards such as air pollution by noxious gases. This in turn requires a staff of chemists with extensive laboratory facilities.

(c) for reasons of safety, it is virtually mandatory that inflammable wastes from different industries or different chemical processes be stored separately to prevent undesirable or dangerous chemical reactions from taking place.

(d) some inflammable wastes could require a form of pre-treatment before they can be safely incinerated.

For these reasons it does not appear reasonable for a regional refuse disposal agency to attempt to provide incinerators for inflammable wastes.

A site, Pellet's Refuse Disposal Area, located on the West half of Lot 14, Concession 8 in the Township of Whitchurch, is currently being used for the disposal of liquid wastes from an area including Metropolitan Toronto and the Central Ontario Joint Planning Area.

With the existence of this site, it would be advisable that no inflammable liquids be accepted for disposal at regional refuse disposal facilities in the Planning Area.

2. Disposal of Acidic and Alkaline Wastes

Based on this survey and other investigations by the Ontario Water Resources Commission, it is apparent that the majority (probably over 90%) of the acidic and alkaline wastes generated in the study area are being satisfactorily neutralized by the industries responsible for their generation, and the neutralized effluents are being discharged to the sanitary sewers. If sludges are produced during the neutralization reactions, these may be dewatered mechanically or in drying beds, after which they can be disposed of at the previously mentioned Whitchurch site.

In recent years, legislation controlling water pollution has become increasingly stringent, and this trend is almost certain to continue. Because of this situation, industries are spending unprecedented sums of money on facilities to treat their acidic, alkalinic and other wastewaters.

Furthermore, it seems reasonable to assume that they will include such treatment facilities whenever new plants are built or existing plants expanded. Accordingly, the disposal of acidic and alkaline wastewaters per se is not expected to pose serious future problems. The disposal of nominal quantities of dewatered sludges resulting from the neutralization of acidic and alkaline solutions is anticipated. However, such quantities are likely to be relatively small in comparison to other solid wastes from residential, commercial, industrial and recreational areas.

The disposal of acidic or alkaline wastewaters on rural lands as is currently practiced to a limited degree should be strenuously discouraged for various reasons, including the following:

(a) the practice is primitive at best and is almost certain to pollute both soil and ground water;

(b) if dumped in a sanitary landfill, acidic wastes could eventually cause serious odour problems through the generation of such gases as hydrogen sulphide, sulphur dioxide, hydrogen chloride, etc;

(c) the practice poses a danger to the workmen in a landfill area and is likely to increase machinery maintenance costs;

(d) liquid wastes generally interfere with the operation of a sanitary landfill site by creating muddy or boglike areas.

3. Disposal of Miscellaneous Wastewaters

The majority of the miscellaneous wastewaters generated in the study area contain relatively inert suspended solids, e.g.:

(i) particulate matter from air pollution control devices;

(ii) Iron and silicon particles from grinding and machining operations involving glass and metallic articles;

(iii) mill scale and other iron particles from metal finishing and steel forming operations.

In many instances, these particles can be removed from the wastewater in sedimentation basins located on the plant premises, after which the clarified effluent may be discharged or re-used. Solids accumulating in such basins should be periodically removed and thoroughly dewatered, after which disposal in a sanitary landfill site may be permitted.

The other miscellaneous wastes mentioned in Chapter V (activated carbon sludge and carbon-black rubber waste) are reported to be mildly inflammable. However, they have been included in this section rather than the inflammable section since they are not nearly as hazardous as the term "inflammable" might infer. Any of these materials, which are not thoroughly dewatered should be disposed of at the Whitchurch site.

CHAPTER X

ADAPTABILITY OF EXISTING FACILITIES

A. GENERAL

The existing refuse disposal facilities in the Planning Area as previously mentioned consist of publically and privately owned landfills together with operating equipment.

B. EXISTING LANDFILLS

In general, the existing municipal landfills are rapidly filling to their capacity and it is not unlikely that most will be completed within the next two years. These sites therefore do not play a part in the long range disposal scheme. The life expectancy of the private disposal sites could not be established but the existing sites are not expected to last beyond this two-year period. The majority of both the private and public landfills with the exception of the Ritson Road site in Oshawa have been operated in a manner which is not consistent with the proposed new Provincial Regulations.

The Ritson Road landfill site was initially a gravel pit which subsequently has been filled with refuse to the level of the existing ground. At present refuse is being placed in a 10 foot lift above this elevation. The capacity of this lift on the present site has been estimated to be some 200,000 tons. This could be increased to an estimated 380,000 if a second 10 lift were utilized.

This site has several problems which make it difficult to carry out sanitary landfilling according to the new proposed standards of the Department of Health. There is at present a drainage ditch along the west side of the site which collects the leachate coming from the fill and decants it slowly to the Oshawa Creek. This problem will only increase with time and with the extra 10 foot lift of refuse. This problem has been overcome by the construction of a small sewage pumping station on the site and a force main to the sanitary sewer on Glovers Road.

A second major problem exists in that there is no material available on the site for either daily or final cover of the refuse. This problem has been solved in the past by the acquisition of excess excavated material from city contracts for use as daily cover. The supply from this source in the past has been scarcely adequate and as the refuse load increases it is unlikely that such contracts will provide sufficient cover on a regular basis.

The present site with a 10' lift of refuse and without acquisition of adjacent property has been estimated to last another five to six years provided only domestic refuse from the City of Oshawa is placed in the site. Its life would be shortened to about 3 years if the City's industrial refuse was accepted. The life of the site would be further shortened to 1 1/2 to 2 years if the site was used for all refuse generated in the Planning Area.

In order that efficient use be made of this site, the 10 foot lift which has been started should be completed, and the site properly finished off with a 4-foot layer of final cover before seeding. This finishing would probably include the importing of considerable cover material either from city contracts or from nearby borrow pits. This finishing will be required under the new regulations once the 10' lift is complete whether the site is finished by the City or the Region.

The operation of two sites in the region does not provide the most efficient disposal system for the region, as shown later in Chapter XI. For this reason the Ritson Road site should not be operated simultaneously with a regional site. It is possible however that even though the life of the Ritson Road site is very short if it is receiving refuse from the whole of the Planning Area, the fact that it is presently established and operating, suggests that its use might be advantageous as the first step in establishing a regional refuse disposal plan. The foremost advantage being that it could be used immediately while the development of the first regional sanitary landfill site was being carried out.

C. UTILIZATION OF EXISTING LANDFILLS

The existing landfill sites in the Planning Area cannot form a significant element in the long term regional refuse disposal plan. Nevertheless they will have to be completed and finished at least to a minimum standard to prevent them from becoming eye sores. Because of these reasons, there does not appear to be any necessity or advantage in a future regional refuse disposal agency assuming responsibility for existing landfills.

The Ritson Road site, although it may serve as a significant phase in the establishment of a regional refuse disposal programme can also hardly be conceived as a significant element in a regional plan. It may also form, when it is completed, a useful adjunct to the City of Oshawa for recreational purposes. It would appear that the Ritson Road site could be operated by the City of Oshawa such that it would be completed at a time in which a regional disposal facility could reasonably be expected to be available by making the site available for any refuse generated in the Planning Area. Any revenue accruing from such an operation by charging for disposal could be used advantageously to assist in the necessary finishing of the site.

D. EXISTING EQUIPMENT

There are at present several pieces of equipment in use at the disposal sites of Oshawa, Whitby and Bowmanville. They are as follows:

Oshawa:-	1 Allis Chalmers HD16 bulldozer equipped with cab, heater, dozer blade and refuse screen used exclusively at the landfill site. 1 weigh scale.
Whitby:-	1 Caterpillar 977K front end loader, with cab used exclusively at the landfill site.
Bowmanville:-	1 small front end loader, used 3 days per week at disposal site and for other jobs in town on the other days.

E. UTILIZATION OF EXISTING EQUIPMENT

The equipment envisaged for the initial stages of the regional programme are one D7E or D8H or their equivalent equipped with a cab, heater, refuse blade and screen for spreading and compacting refuse and a D7E and tractor drawn scraper for hauling and spreading cover material. The tractor intended for compaction duty would be equipped with a hydraulic ripper for loosening cover material.

The bulldozer presently assigned to the Ritson Road site is suitable for use as the compaction machine on a regional disposal site if it were equipped with a ripper.

The weigh scale recently purchased by the City of Oshawa could also be utilized for a regional disposal site. The scale would require minor modifications which could be added at the time of its moving to a regional site. The modifications including a dial indicator and data readout facilities would be advisable to avoid delaying collection trucks and to facilitate billing procedures.

The remainder of the equipment does not appear to be readily adaptable to a regional site.

CHAPTER XI

ALTERNATIVE REFUSE DISPOSAL PLANS

A. GENERAL

This chapter of the report is concerned with various alternative plans which may besuitable for the disposal of all wastes generated in the Planning Area in the ensuing 18-year period to 1986. In considering various alternatives, particular emphasis must be placed on determining the most economical plan. Based on data presented in previous sections, comparative studies have been made regarding the costs of haul and disposal of solid wastes in the study area.

It has been indicated that the most practical and economical method for disposal of solid wastes in the Planning Area is sanitary landfill, however incineration has been considered as a viable alternative to sanitary landfill and the economic comparisions carried out in this chapter are intended to show its relative merit.

Estimated quantities of privately and municipally collected residential, commercial and industrial refuse shown in Chapter V represent over 70 per cent of the total solid refuse generated in the Planning Area, and are the basis for comparative cost studies. Other wastes of special nature require special disposal methods and thus are not included in the comparative cost studies for alternative refuse disposal plans.

If the costs of refuse disposal were the sole criteria in determining the most economical solution to the problem undoubtedly large landfills in remote locations would appear to be the least expensive solution. However, in achieving such apparent economy in disposal cost, the cost to the area municipalities and private organizations engaged in the collection and haul of refuse would be totally ignored. Similarly, if haul cost were the sole criteria for determining the most suitable plan, the desire for short hauls would result in a large number of small and relatively costly refuse disposal sites. Thus in determining the plan most economical for the Planning Area as a whole, optimum economy requires that the total cost for both disposal and haul be as low as practicable. The economic studies discussed herein are directed toward obtaining that result.

B. BASIS OF PLAN COMPARISONS

The results of the site scoring system described in Chapter VII provided nine sites which were physically desirable to use as sanitary landfills. The 9 sites were then analysed economically, both singly and in groups of two or three, to determine which would best fit into the regional system.

In addition to comparing the 9 sites from the scoring system, an incinerator site was selected in the industrial area of Oshawa below Hwy. 401 for the purpose of analysing the system cost of incineration.

The cost comparisons of the various sites studied were based on the quantities of residential, commercial and industrial refuse generated in the Planning Area estimated for 1971 as shown in Tables V-3, V-5 and V-7.

It is recognized that the quantities of commercial refuse shown in Table V-5 include refuse collected both privately and municipally. These quantities have been considered separately in the economic comparison of sites since municipal and private haul rates are different. It should also be noted that a small portion of the residential refuse is collected privately however the quantity is insignificant and for the economic comparison all residential refuse is considered to be municipally collected.

Unit costs previously developed as being representative of 1968 cost levels have been used in making economic comparison studies. These include costs of incineration, cost of disposal by sanitary landfill at each of the possible sites studied and costs of refuse haul in collection vehicles by the collection agencies.

The alternative plans considered herein for refuse disposal are based on the premise that the regional refuse disposal operating organization will be able to acquire and develop sites for sanitary landfills and/or incinerators as proposed in each of the plans. It is also assumed all municipally and privately collected refuse in an area are hauled to the same disposal facility.

C. ALTERNATIVE PLANS CONSIDERED

The plans for refuse disposal studied include disposal by sanitary landfill, and central incineration. Hauling was considered to be direct to the disposal site by the collection vehicles.

The specific Plans studied are as follows:

Plans 1 to 9 incl.	All refuse to be direct hauled to sanitary landfill sites EW-6, EW-11, EW-10, W-2, W-12, D-11 to 13, D-1, W-4 and D-14 respectively. Each plan to involve the use of only one site.

Plan 10	All refuse to be direct hauled to sanitary landfills W-2 and D-1 considering refuse is hauled from each generation area to the closer landfill site.
Plan 11	All refuse in Whitby to be direct hauled to site W-4; all refuse in Oshawa and East Whitby to be direct hauled to EW-6, and all refuse in Bowmanville and Darlington to be direct hauled to site D-21. Site D-21 was deleted from the scoring system (Chapter VII) because of low capacity. In this plan the quantities generated in Bowmanville and Darlington made it reasonable to consider this site for restricted use.
Plan 12	All refuse direct hauled to a single new incinerator located in Oshawa in planning district No. 13.

It must be recognized that in making studies of the Plans outlined above that many of the ones involving sanitary landfills do not have sufficient capacity to last for the 18 year project period.

As such it will be necessary to combine two or more of these Plans into a programme to provide adequate landfill space to last for the full 18 years of the project period.

D. DEVELOPMENT OF COMPARATIVE COSTS

1. Refuse Quantities

The estimated quantities of residential, commercial and industrial refuse collected in each of the 16 planning districts are shown in Tables V-3, V-5 and V-7, respectively. In developing costs for each of the sites compared, the total quantity of solid wastes generated in each district was assigned to the proposed disposal site, thus each site when considered singly received all refuse generated in the Planning Area. In the case of the two or more sites being considered simultaneously the refuse from each planning district was considered to go to the closer landfill site.

2. Direct Haul Costs

The costs of direct haul in collection vehicles to respective disposal sites have been developed by assuming that all refuse generated in each particular district and direct hauled to a given disposal site is hauled over the most logical direct route. Individual unit costs developed earlier in the report for haul over high speed thoroughfares, rural roads and ordinary city streets, and in municipal or private vehicles, respectively, have been recognized.

3. Disposal Costs

The unit costs of sanitary landfills are dependent upon the rate of filling as previously described in Chapter VII. That chapter indicates the unit costs peculiar to each particular sanitary landfill site as well as operation and maintenance costs common to all sites.

The annual cost of disposal as shown in Plan 12 allows for the incineration of 85% of the generated refuse in 1971 at the costs shown in Chapter VIII for incineration in the 795 ton per day plant, and for disposal of the 15% non incinerable refuse at a landfill site at the cost of $5.00 per ton.

E. TOTAL COSTS OF HAUL AND DISPOSAL

The estimated annual costs of all Plans, based on 1971 refuse quantities and 1968 (current) cost levels are shown in Table X1-1. The table shows private and municipal direct haul costs, disposal costs and total costs on an annual basis.

An examination of Table X1-1 reveals the following:

(a) Plan 12, involving central incineration, is considerably more costly than any other Plan.

(b) Plan 6 is noticeably more costly than the remaining Plans.

(c) Plans 2, 3, 4, 5, 8, 9, 10 and 11 are approximately the same cost. (within ± 6% of their average total annual cost).

(d) Plans 1 and 7 are approximately the same cost and are significantly less costly than the other Plans (approximately 12% less costly than the average costs of Plans 2, 3, 4, 5, 8, 9, 10 and 11).

Thus it may be concluded that Plan 1 and Plan 7 fulfill the objective that the regional refuse disposal system operate at minimum total annual cost.

F. FURTHER CONSIDERATIONS OF ALTERNATIVE PLANS

From the system cost analysis it is apparent that Plan 1 or Plan 7 represent the most economical solution to the refuse disposal problem in the Planning Area. It must also be noted that neither Plan 1 nor Plan 7 have sufficient capacity to provide sanitary landfill space until 1986.

It is estimated that if Plan 1 were put into operation now, the site would be completed in 1983 and if Plan 7 were put into operation now the site would be completed in 1977. The two Plans, if instituted successively, would last well beyond 1986.

If the sites required for Plans 1 and 7 cannot be obtained, or once they have been completed, then any of the sites envisaged for Plans 2, 3, 4, 5, 8, 9, 10 or 11 meet the requirements of a regional sanitary landfill site.

The estimated capital expenditures necessary to purchase, develop and equip the sites envisaged for Plans 1 and 7 based on 1968 cost levels are as follows:

(a) Plan 1

Site purchase and development	$465,000
Equipment purchasing	185,000
Total	$650,000

(b) Plan 7

Site purchase and development	$600,000
Equipment purchasing	185,000
Total	$785,000

G. PROJECTIONS

Projections of total annual costs based on 1968 cost levels for haul and disposal under Plans 1, and 7 for 1971, 1976, 1981 and 1986 are summarized in Table XI-2.

As the most economical solution to the waste disposal problem in the Planning Area, throughout the 18 year period is the operation of only one site at a time, the projected annual costs reflect this mode of operation.

The effect of possible inflationary tendencies on cost levels have been considered in projecting the annual costs for the alternative disposal plans. For this report, an allowance of an annual increase in operating and maintenance costs amounting to 4 per cent per year through 1976 is considered reasonable. Further projection of possible cost increases beyond 1976 is so speculative as to be of practically no value.

The inflationary allowance was applied to all costs of haul and disposal except those related to initial capital expenditures for which long term debt financing is contemplated. The latter includes land acquisition and sanitary landfill site development. The inflationary allowance was applied to all operation and maintenance costs as well as vehicles, landfill equipment and other relatively short-lived capital investment items.

The effect of recognizing an inflationary allowance of 4 per cent per year is to project a significant increase in costs in future years, far in excess of the overall increase contemplated to result merely from increased refuse quantities.

TABLE XI-I

ALTERNATIVE PLAN ANNUAL COSTS - 1000 DOLLARS

(1971 - QUANTITIES - 115,579 Tons per year)

ITEM	PLAN 1	PLAN 2	PLAN 3	PLAN 4	PLAN 5	PLAN 6	PLAN 7	PLAN 8	PLAN 9	PLAN 10	PLAN 11	PLAN 12
Disposal Site (s)	EW-6	EW-11	EW-10	W-2	W-12	D-11 to 13	D-1	W-4	D-14	D-1 & W-2	W-4, EW-6 & D-21	Incinerator
Municipal Haul	91	90	95	78	110	88	75	102	81	55	68	68
Private Haul	115	111	118	84	126	93	78	113	86	60	85	62
Disposal	279	354	301	388	319	439	326	356	356	409	421	1030
Total	489	555	514	550	555	620	479	571	523	524	574	1160

TABLE XI-2

PROJECTIONS OF TOTAL ANNUAL COSTS

1971 - 1986

	1971	1976	1981	1986*
Fixed Disposal Cost	$88, 000	$88, 000	$88, 000	$197, 000
Variable Disposal Cost	191, 000	209, 000	229, 000	257, 000
System Haul Cost	206, 000	260, 000	318, 000	294, 000
System Annual Cost	$485, 000	$557, 000	$635, 000	$748, 000
Annual Tonnage	115, 579	144, 009	176, 066	213, 990

* Cost Projections Reflect Commissioning of Site D-1 in 1983.

CHAPTER XII

POLICY, ORGANIZATION AND FINANCING

A. GENERAL

In order to implement and operate the long term regional refuse disposal programme developed by this study, certain policy changes are indicated, a control organization must be established, and procedures for financing the operation must be instituted. The following is a comparison of some of the alternatives available in regard to these matters and in some cases recommendations which are believed to be desirable.

B. POLICY

Certain policies with regard to refuse disposal have been assumed in the development of the study and other desirable policies have been revealed as a result of the study. Some of these policies are self-evident but a statement of them is appropriate.

(a) The most significant policy change inherent in the development of the regional refuse disposal programme is that responsibility for disposal of ostensibly all refuse in the Planning Area will be assumed by one agency. The adoption of this policy is essential in order to attain the desirable environmental goals consistent with economic considerations.

(b) The recognition that refuse disposal is a regional problem is also inherent in the development of the study. A policy resulting from this recognition is that the cost of refuse disposal, at least in principle, should be the same throughout the region independent of the generation point. This policy implies that differences in haul distances should be recognized and that some method for equalizing haul distances should be introduced into the system for charging for refuse disposal.

(c) There are a variety of ways in which the monies necessary for the institution and operation of a regional refuse disposal programme can be realized. The method utilized, is affected to a degree by whether the function is viewed as a service or a utility. In general, it appears desirable to view the refuse disposal operation as a utility. The resultant implication is that the refuse disposal costs would be realized by charges based on the rate of use.

There are a number of other policies or practices which are desirable as guidelines for the proper operation of a regional refuse disposal system. They are as follows:

(a) The standards recommended throughout this study for the design, development and operation of the disposal facilities are equal to the best current practices on this continent and comply with, if not exceed, the proposed minimum standards as proposed by the Ontario Department of Health. The adherence to these standards is in keeping with the general high quality of operation attained by other public services and is mandatory to prevent refuse from becoming a pollution hazard.

(b) At present in the Planning Area the five municipalities are each responsible for their own refuse collection and disposal of residential and some commercial refuse while independent private contractors are responsible for the collection and disposal of the rest of the commercial refuse and all of the industrial refuse. The municipalities to the present time have exhibited a high degree of co-operation both in the commissioning and the preparation of this report. Private enterprise has also shown a willingness to co-operate during the preparation of this report. For the systems to function successfully, full and continued co-operation of all parties concerned is essential.

In order to permit the necessary exchange of information essential for close co-operation between the interested parties, it is suggested that a technical advisory committee be established. The membership should comprise representatives of the participating municipalities, private contractors and industry.

(c) Many possible unforeseen changes may occur in technology, refuse characteristics, etc., which may necessitate modifications to the long range plan as recommended in this study. In order to facilitate such adjustments, complete and concise records of past performance and characteristics are necessary. Special care must be taken in establishing a system which will ensure that such records are kept up to date and are in usable form. Aside from the necessary constant review of the study recommendations, it will be essential to submit them to a rigorous review at intervals not exceeding five years.

(d) As has been mentioned previously, the problems of refuse disposal are being subjected to analysis by qualified groups to a degree never before experienced. The possibilities of these efforts affecting advantageous changes in refuse disposal must be realized. To be able to judge the value of new suggestions requires conscientious study by those responsible to keep abreast of new developments. This can be accomplished in a variety of ways such as participating in technical conferences, encouraging suggestions and experiments by private entrepreneurs and actively co-operating in research with such groups as the Department of Health of the Province of Ontario.

(e) In the past, refuse disposal practices in the Planning Area, as in many other communities, have not enjoyed the best of public relations. To some degree the problem is inherent in refuse disposal, but too often is the result of inadequate finances and effort on behalf of the disposal agency. The basis for good public relations is to conduct a first class disposal operation and then ensure that the public is made fully aware of the problems facing the disposal agency and the energetic approach which is taken toward their solution. A sound public relations programme will amply repay its cost by engendering public confidence and in facilitating public approval for the funds required for operation and future expansions of the disposal facilities.

(f) Although the establishment of policy is not affected, the following is pertinent to the establishment of a regional refuse disposal plan.

Prior to the 1st Session, 28th. Legislature, Ontario, 17 Elizabeth II, 1968, it was possible for any municipality, under the authority of the Municipal Act to prohibit the dumping of refuse within its boundaries by any other municipality. During the above legislature session the Municipal Act was amended by Bill 155. (The result is that the provisions respecting garbage disposal are extended to facilitate the locating of disposal sites outside the confines of any one municipality.) The following extracts are taken from Bill 155:

" (4) Paragraph 75 of subsection 1 of the said section 379 is amended by striking out "and for acquiring land within the municipality or in any adjacent municipality with the consent of the council thereof for any of the purposes of this paragraph" in the sixth, seventh, eighth and ninth lines, so that the paragraph, exclusive of the clause, shall read as follows:

"75. For establishing and maintaining a system for the collection, removal and disposal of garbage or of garbage and other refuse or of ashes, garbage and other refuse, and for contracting with any person for the collection, removal and disposal by him of ashes, garbage and other refuse upon such terms and conditions as may be deemed expedient, and for erecting and maintaining with the approval of the Department of Health such buildings, machinery and plant as may be deemed necessary for the purposes of this paragraph.

" (5) Paragraph 76 of subsection 1 of the said section 379 is repealed and the following substituted therefor:

"76. For acquiring land in any local municipality or in territory without municipal organization for any of the purposes of paragraph 75.

(a) No land shall be acquired in a local municipality under this paragraph without the approval of the local municipality, which approval may be granted upon such terms and conditions as may be agreed upon, or failing such approval or agreement, the approval of the Municipal Board, and no land shall be acquired in territory without municipal organization under this paragraph without the approval of the Municipal Board.

(b) The Municipal Board, before giving its approval under this paragraph, shall hold a public hearing and shall give or cause to be given at least ten days notice of the hearing to the clerk of the local municipality concerned and to such other persons in such manner as the Municipal Board may direct and the Municipal Board, as a condition to giving any such approval, may by its order impose such restrictions, limitations and conditions respecting the acquisition or use of such land as to the Municipal Board may appear necessary or expedient and the Municipal Board may order the amendment of any official plan or of any by-law passed under section 30 of The Planning Act to permit the use of the land for the purposes for which it is to be acquired."

(g) It has been the practice in the Planning Area to permit private cars, trailers and light trucks access to the disposal sites at virtually all times. With increased rated of loading which can be expected at a regional site this may lead to problems. Such vehicles are time consuming to weigh and unload and can create disruptions at the working face. On the other hand, providing ready access to public disposal facilities probably decreases the amount of refuse thoughtlessly discarded along public roadways and on private property. For this reason, it may well be advisable to encourage such access to the disposal facility. This could take the form of a bulk container recessed for easy access by the public. This container could be rented from a private refuse haulage contractor who would be responsible for periodically unloading it at the working face.

C. ORGANIZATION

In order to initiate and administer a regional refuse disposal programme for the Planning Area, some form of administrative agency must be established. Several alternative forms exist for this central agency. In choosing the most desirable form for such an agency the following objectives should be considered:

(a) the agency must be ultimately responsible to the people of the region.

(b) the agency must be capable technically of administering the programme.

(c) the agency's administrative and procedural authority should be as simple as possible.

(d) the agency must perform its function at reasonable costs.

(e) the agency must be capable of exercising reasonable control and adjusting quickly to meet unforseen conditions.

There are certain personnel requirements for operating a regional programme which are virtually independent of the form of the control agency. These requirements are generally for the field staff and include equipment operators, weigh master, watchman etc. and immediate supervisor. It is of course essential that such personnel be properly trained and experienced in order to satisfactorily operate a regional disposal programme.

Some of the obvious alternatives for the form of the control agency are as follows:

1. The most obvious solution to the problem would be to make the initiation and operation of a regional refuse disposal programme one of the functions of a regional government. Such a form of government does not exist in the Planning Area. To predicate the institution of a regional refuse disposal programme on the existence of regional government would probably delay its institution to the prejudice of the many benefits of such a programme.

2. The Central Ontario Joint Planning Board could operate the regional refuse disposal programme. If the Board were to operate the programme special provisions would have to be made for the financing of capital works since the Board is specifically restricted from the raising of capital funds. The Board however is not operational service oriented and the operation of a refuse disposal programme would be a significant departure from its normal functions.

3. The refuse disposal facilities could be operated under private contract. It would probably be desirable for the participating municipalities to obtain the necessary sites for refuse disposal since private operators are much more restricted in their abilities to obtain such sites than are the municipalities. Some form of public agency would still be required to administer the disposal contract. Such a system, although apparently simple in conception, might be difficult to administer such that objectives involving pollution control, aesthetics, public acceptance, etc could be achieved.

4. A new commission could be established to administer the refuse disposal programme. Such a commission could be formed by representatives from the participating municipalities and the commission could acquire its own staff, monies, etc. Support service costs to provide the necessary functions of personnel administration, pay and accounts, etc., would be relatively expensive if provided by a new commission. The establishment of sufficient autonomy for the commission to permit efficient operation and still maintaining political accountability could be a problem. The formation of a commission would contribute to the general proliferation of independent commissions. On balance the formation of a new commission for such a function does not seem advisable.

5. The refuse disposal programme could be administered by the municipality in which the disposal facility is situated. The main disadvantage of such a system would be the dislocation of the operation, suffered when the disposal facility moved from one municipality to the other. The scale of the operation might also be large enough to cause significant differences in the administrative functions of some of the municipalities.

6. The refuse disposal programme could be administered by any one of the member municipalities of the Central Ontario Joint Planning Board. The most obvious municipality to assume this responsibility is the City of Oshawa. There are a number of reasons why this form of administration may be desirable:

(a) The senior technical expertise necessary to perform the function is available in the Public Works Department of the City of Oshawa.

(b) Existing staff, experienced in the operation of a sanitary landfill, can be readily expanded to operate a larger regional site.

(c) Functions such as personnel administration, cost accounting, equipment rental, billing, payroll records for operating personnel etc. necessary for a regional site can be absorbed in the existing City of Oshawa system without undue disruption.

Political accountability can be attained under such a system. The Public Works Department of the City of Oshawa would of course, be responsible to the elected officials of the City of Oshawa and the participation of the other municipalities could be the subject of contracts or agreements between these municipalities and the City of Oshawa. These agreements should be carefully drawn and spell out in detail, the method of calculating the charges to be levied. These agreements could be subject to annual review or extension at the discretion of either party.

Of the available alternatives it is believed that a disposal system under the direct control of the Department of Public Works of the City of Oshawa can best meet the objectives outlined originally for the central administrative agency.

D. FINANCING

The procurement and disbursement of monies required for the implementation and operation of the regional refuse disposal system can be grouped into two categories; those required for capital expenditures to purchase and establish the disposal facilities and operating equipment and those required for operating expenses, salaries and overhead expenses.

1. Capital Financing:

Capital money will be required to purchase the site, develop the site and purchase the operating equipment initially. Presumably the money would be raised by issuing debentures. The debentures would have to be issued or guaranteed by the participating municipalities. Each municipality could issue debentures for a share of the necessary initial expenditures or the debentures could be issued by one municipality with the other municipalities assuming liability for a predetermined share of the debentures. Both these methods are commonly used in municipal financing for such joint ventures. If the City of Oshawa were to become the executing agency for the regional refuse disposal plan it would appear logical for Oshawa to issue all the debentures after acquiring the appropriate guarantees from the other municipalities.

At the moment there is apparently no financial assistance available from either the Provincial or Federal Authorities for this type of activity.

A possibility that should be investigated is financing by the Ontario Municipal Improvements Corporation (O. M. I. C.). Normally, this agency is looked upon as a buyer of debentures of the last resort. Its interest rates are about 7 percent. In the current money market where municipalities are having to pay 8+ per cent, the O. M. I. C. arrangement may be attractive. The availability of funds for debenture purchasing from this source varies from day to day. Thus it would be necessary to check this source near the time that financing is contemplated.

Capital requirements for initiation of the regional refuse disposal scheme are shown in Chapter XI. The cost sharing basis for initial capital requirements among participating municipalities could be on either a per capita or assessment basis.

2. Operating Financing:

As mentioned previously, it appears advisable that the refuse disposal operation be operated as a utility and thus be self-supporting as much as possible with the rates charged based on the use of the facilities. A convenient method is to charge for disposal on a per ton basis. Also, as previously mentioned, there should be some attempt in the method of charging for disposal to recognize that haul distances are not similar for all municipalities.

This recognition can be made reasonably easily for municipally hauled refuse. For privately hauled refuse the difficulties to be encountered in determining the origin of the refuse would cause undue complications in applying a variable haul distance formula to charges for refuse disposal.

The rates for disposal should include the following charges:

(a) Debt service charges for land purchase.

(b) Debt service charges for site development.

(c) Debt service charges for initial equipment purchases.

(d) Labour costs including salaries, employee benefits and overhead for operating staff.

(e) Equipment operating costs.

(f) Equipment depreciation costs.

(g) Charges sufficient to accumulate necessary final finishing costs.

An example of a method for calculating charges is included assuming the use of the Plan 1 site based on 1971 quantities and 1968 costs. Haul distances are calculated assuming that all refuse originates at the centre of the appropriate Planning District and measuring the shortest distance over the particular type of road to the site. The haul costs used are those developed in Chapter VI and are believed to be reasonable haul costs.

Table XII - 1 shows the annual 1971 refuse quantities from each municipality. Table XII - 2 shows the measured mileage for municipal refuse from each planning district in each municipality. Table XII - 3 shows the total haul costs and the haul cost per ton of municipal refuse for each municipality and the average haul cost per ton for all municipal refuse. Table XII - 4 shows the calculation of two different disposal costs. One is the cost per ton for disposal only and the other is the cost per ton for haul and disposal for municipal refuse. Table XII - 5 shows the disposal charges for municipal refuse with a rebate allowance for haul. Table XII - 6 shows a summary of total revenue for refuse disposal based on a charge for private disposal of $2.42 per ton and the charges shown in Table XII - 5 for municipal refuse.

It is believed that the illustrated method of determining refuse disposal charges is relatively straight forward and representative of actual charges. The charges of course are subject to revisions as costs become more accurately known. They also will be subject to annual revisions as a result of greater accuracy in determining anticipated refuse quantities as a result of experience.

TABLE XII-1

ANNUAL REFUSE QUANTITIES (1971)

	Private Tons	Municipal Tons	Total Tons
Oshawa	35, 824	29, 965	65, 789
Whitby	17, 497	8, 926	26, 423
Bowmanville	4, 400	3, 327	7, 727
East Whitby	1, 725	1, 067	2, 792
Darlington	9, 344	3, 504	12, 848
Total	68, 789	46, 789	115, 579

TABLE XII-2

HAUL MILEAGES TO SITE EW-6

(Miles)

	Planning District	Low Speed Route	Medium Speed Route	High Speed Route
Oshawa	10	2.5		
	11	5.5		
	12	4.0		
	13	6.0		
Whitby	1	0.5	12.5	
	6a	2.0	7.5	
	6b	2.0	7.5	
	6c	2.5	7.5	
	6d	3.0	7.5	
	6e	4.0	7.5	
	7a & b	2.0	7.5	
	7c	2.0	5.5	
	8a	2.0	5.0	
	8b	2.0	5.0	
	8c	2.0	5.0	
Bowmanville	16a	2.5	4.0	8.5
	16b	3.5	4.0	8.5
East Whitby	2		4.5	
	9		1.5	
Darlington	3a		7.0	
	3b	0.5	9.0	
	3c	0.5	9.0	
	4	0.5	6.5	
	5a & b	0.5	11.0	
	14a		7.0	
	14b		9.5	
	14c	1.0	7.5	
	14d	1.0	11.0	
	15	3.0	5.5	3.5

TABLE XII-3

HAUL COSTS (Municipal Refuse, 1971 quantities)

	Total Haul Costs	Avg. Haul Cost per Ton
Oshawa	$51,224.16	$1.71
Whitby	21,155.56	2.37
Bowmanville	12,246.47	3.68
East Whitby	503.10	0.47
Darlington	6,253.78	1.78
Total Haul Costs (Municipal Refuse)	$91,383.07	

Overall weighted average haul cost (on basis of tons refuse generated) $1.95

Note: Haul costs calculated from rates as follows:

(a) Low Speed Routes = $0.39 per ton mile

(b) Medium Speed Routes - $0.20 per ton mile

(c) High Speed Routes - $0.18 per ton mile

TABLE XII-4

BASIC REFUSE DISPOSAL RATES

1971 Total Annual Disposal Cost (Table XI-1)	$279,000.00
1971 Total Annual Tonnage	115,579. tons

Therefore, Total Disposal Cost per ton = $\frac{279,000}{115,579}$ = 2.413/ ton Say 2.42/ton

Therefore, Base Rate Charge to Municipalities for Haul and Disposal 1.95 ± 2.42 = $4.37/ton

TABLE XII-5

MUNICIPAL REFUSE DISPOSAL CHARGES

	Base Rate Charge Per Ton	Haul Rebate Per Ton	Payment Per Ton
Oshawa	$4.37	$1.71	$2.64
Whitby	4.37	2.37	2.00
Bowmanville	4.37	3.68	0.69
East Whitby	4.37	0.47	3.90
Darlington	4.37	1.78	2.59

TABLE XII-6

TOTAL REVENUE SUMMARY

	Municipal Refuse Tons Per Year	Payment Per Ton	Sub-Total	Private Refuse Tons Per Year	Payment Per Ton	Sub-Total
Oshawa	29,965	2.66	$79,706,90	35,824	2.42	$86,694.08
Whitby	8,926	2.00	17,852.00	17,497	2.42	42,342.74
Bowmanville	3,327	0.69	2,295.63	4,400	2.42	10,648.00
East Whitby	1,067	3.90	4,161.30	1,725	2.42	4,174.50
Darlington	3,504	2.59	9,075.36	9,344	2.42	22,612.48
			$113,091.19			$166,471.80
TOTAL ANNUAL REVENUE			279,562.99			
ESTIMATED TOTAL ANNUAL COST			279,000.00			

CHAPTER XIII

FINAL OBSERVATIONS AND RECOMMENDATIONS

A. GENERAL

From the foregoing, it is possible to draw certain conclusions and make certain recommendations leading to the establishment of a regional refuse disposal plan to provide for refuse disposal in the Central Ontario Joint Planning Area until the year 1986.

All estimates of capital construction costs are based on 1968 costs and a Engineering News Record cost of construction index of 1122 and must be adjusted according to the index pertaining to the time of construction. The cost estimates are also subject to possible adjustment as a result of detailed preliminary and final engineering studies.

Estimated costs for all facilities required are shown on the basis of 1968 costs as the determination of an inflationary allowance would not be particularly valid.

B. FINAL OBSERVATIONS

As a result of these studies the following final observations are made:

1. The best long-term disposal method suitable for the Central Ontario Joint Planning Area is sanitary landfill.
2. There are a sufficient number of desirable landfill sites within the Planning Area to last well beyond 1986.
3. There is an established disposal site in Whitchurch Township outside the Planning Area where liquid wastes can be disposed of in an acceptable manner.
4. There are no desirable sanitary landfill sites of any consequent size within the City of Oshawa, the Town of Bowmanville and the original Town of Whitby.
5. The economic analysis of the refuse disposal system indicated that the operation of a single sanitary landfill in the Planning Area provides the most economical solution to the problem of refuse haul and disposal.

6. The existing sanitary landfill on Ritson Road North in the City of Oshawa is of sufficient size to last approximately two years if all refuse generated in the Planning Area were deposited there.

7. The use of a transfer haul system from any or all of the municipalities to the landfill site does not provide as low a system cost as direct hauling of refuse in collection trucks.

8. The administration of the regional system could best be accomplished by the Public Works Department of the City of Oshawa.

9. The equipment used on the City of Oshawa Ritson Road sanitary landfill site could be utilized in a regional landfill site.

10. There does not appear to be any advantage in assumption of existing disposal facilities by a regional refuse disposal organization.

11. The cost of refuse disposal should be realized by charging for disposal on a per ton basis. In recognition of varying haul distances, provisions should be incorporated in the rate structure to permit a form of equalization of municipal haul costs.

12. The economic comparisons used throughout the report are sensitive to the location, cost of development and characteristics of the landfill sites. They are based on the landfill sites recommended.

13. The economic analysis are also sensitive to possible changes in refuse characteristics, inflationary tendencies, and other indeterminate factors. The system recommended for adoption is believed to be adaptable to conform to these changes.

14. The system facilities must be sized and scheduled for installation such that capacity is available as required from the forecasts of refuse quantities. The forecasts are subject to change based on experience as it is gained.

C. RECOMMENDATIONS

In view of the foregoing findings of the study the following recommendations can be made:

(a) Following the approval in principle of a regional refuse disposal program by the councils of participating municipalities, agreements regarding sharing of capital costs and methods of charging for refuse disposal should be executed.

(b) The appropriate approvals for the use of site EW-6 as a sanitary landfill should be obtained.

(c) Site EW-6 should be purchased and developed as the first regional refuse disposal sanitary landfill site - estimated cost $650,000.00.

(d) Serious considerations should be given to the acquisition of site D-1 at an early stage to ensure its use as a sanitary landfill by about 1983.

Figure XIII-1 shows the location of the recommended sanitary landfill sites.

APPENDIX A

Earlier Studies and Municipal Documents Reviewed

1. All existing Official and draft Official Plans and Zoning By-Laws that have been prepared by the various Municipalities in the Central Ontario Joint Planning Area.
2. Various reports on population, physical features, parks, etc. that have been prepared by the Central Ontario Joint Planning Board.
3. Documents, letters, etc., from the member municipalities outlining their methods of refuse collection, disposal, population, industrial development, disposal costs, refuse quantities, etc.
4. Various By-laws of member municipalities regarding solid and liquid waste disposal practices.
5. "Water Pollution Survey of the Township of Whitchurch" dated April 1966 by the Ontario Water Resources Commission.
6. Unpublished data of the Ontario Water Resources Commission pertaining to the pollution of ground water in the Planning Area from the disposal of solid and liquid wastes.
7. Various documents published for the Central Lake Ontario Conservation Authority showing drainage information.

APPENDIX B

AGENCIES INVOLVED IN REFUSE DISPOSAL PRACTICES

Several legislative, administrative and judicial agencies have an active interest in and may maintain some form of control over the methods of refuse disposal which are practiced in the Central Ontario Joint Planning Area. Some of these agencies are actively involved in controlling refuse disposal, while others are only marginally involved. The following list represents most of these agencies:

A. Federal Departments and Agencies

Department of Health and Welfare

(their concern is with international waterways, ships, national defence installations, etc.)

Department of Transport

(administration of the Navigable Waters Protection Act)

Department of Public Works

(control of harbour development)

Atomic Energy Control Board of Canada

(radio-active waste disposal)

B. Provincial Departments and Agencies

Department of Energy and Resources Management

(the Ontario Water Resources Commission charged with the protection of lakes and streams from pollution and the Conservation Branch who are involved with flood plain land use are under the jurisdiction of this Department).

Department of Health

(this Department is concerned with air pollution and health hazards generally and will be involved in approving and controlling the operation of disposal facilities).

Department of Municipal Affairs

(the Ontario Municipal Board, arbitrator of several of the provisions of Bill 155, are a part of this Department.)

C. Local and Regional Groups

County Health Units and M.O.H.'s.

Central Lake Ontario Conservation Authority

Air Pollution Control Authorities

Various Municipal Councils and Departments such as Parks and Recreation, Oshawa Harbour Commission, Works, Planning Boards, etc., are involved in various aspects of refuse disposal.

APPENDIX C

Ontario Department of Health
Public Health Engineering Service

Tentative Waste Disposal Engineering Standards

Sanitary Landfill Standards

Section 1 - Design

1. Maps - The design data of the proposed sanitary landfill shall include one or more topographic maps at a scale of not over 200 feet to the inch with 5-foot contour intervals. These maps and accompanying data shall indicate the following: - The proposed fill area; any borrow area; access road; on-site road; grades for proper drainage of each cell required and a typical cross-section of a cell; special drainage devices if necessary; fencing; any structures on the site shall be shown, existing and proposed utilities; and all other pertinent information to clearly indicate the soil characteristics, water table, orderly development, operation, and completion of the sanitary landfill. A land use plan of the adjacent areas may be required. The detail of the buffer zone will be shown. The routes proposed for hauling from collection areas will be presented.

2. Geology - The geological characteristics of the proposed site shall be determined by on-site testing or from earlier reliable survey data to indicate soil surveys, water tables and subsurface characteristics such as direction and gradient of groundwater flow.

3. Characteristics of cover material - The soil used as cover material shall be of such character that it can be compacted to provide a tight seal, does not crack excessively when dry, and is free of putrescible materials and large objects. A 25 pound sample and details as to source may be required with each initial application, and renewals.

4. Water Pollution - Sanitary landfill operations shall be limited to areas where water pollution will not create a health hazard. Provision of a seal between the refuse and the water table which is satisfactory to the Department may be required.

5. Equipment - Adequate numbers, types, and sizes of equipment shall be used in operating the landfill in accordance with good engineering practice and with these standards. A list of equipment will be required with each initial application and renewal.

6. Plans and specifications - All sanitary landfills shall be designed in accordance with these standards by a professional engineer. Detailed plans, specifications, and necessary reports shall be submitted by the engineer to the Department for review, approval and file. Any proposed alterations or deviations from these plans must also be submitted for approval and file.

Section 2 - Preparation of the Site

1. On-Site roads - On-site roads shall be designed and constructed so that daily operating traffic will flow smoothly and will not be interrupted by ordinary inclement weather. They must be suitable for carrying traffic in all seasons.

2. Employee facilities - Suitable shelter and sanitary facilities shall be provided and maintained for personnel.

3. Communications - Telephone or radio communications shall be provided at the sanitary landfill site.

4. Measuring facilities - Means shall be provided for obtaining accurate measurement of refuse delivered to the site by weight and/or volume.

5. Fire protection - Suitable measures acceptable to the Department and other responsible authority shall be taken to limit and control fires.

Section 3 - Operations

1. Limited access - Access to a sanitary landfill shall be limited to those times when an attendant is on duty and only to those authorized to use the site for the disposal of refuse. Access to the site by unauthorized persons shall be restricted by suitable fencing.

2. Receptacle - A receptacle shall be provided outside the gate to receive refuse from households during the periods the site is closed.

3. Unloading of refuse - Unloading of refuse shall be continuously supervised by the operator of the disposal site.

4. Blowing paper - Measures shall be provided to control blowing paper. The entire area shall be inspected and tidied regularly.

5. Spreading and compacting of refuse - Refuse, except as exempted in Item 14, shall be spread so that it can be compacted in layers not exceeding a vertical depth of 2 feet of compacted material.

6. Compaction - Compaction will be carried out to achieve an average apparent density in pounds per cubic foot satisfactory to the Department.

7. Volume of cells - Each cell consisting of one or more compacted layers shall not exceed the maximum 24 hour quantity of wastes.

8. Daily cover- A compacted layer of at least 6 inches of approved cover material shall be placed on all exposed refuse by the end of each working day.

9. Final cover - A layer of approved cover material compacted to a minimum thickness of 2 feet shall be placed over the entire surface of each portion of the final lift as soon as possible following the placement of refuse within that portion, so as to prevent fly emergence and rodent infestation. In no case will the delay be longer than one week following the last placement of refuse in the cell.

10. Maintenance of cover - All final cover must be maintained for a period of two years in such a manner as to prevent fly emergence and rodent infestation.

11. Equipment maintenance - Provisions shall be made for the routine operational maintenance of equipment at the landfill site and for the prompt repair or replacement of landfill equipment.

12. Sewage solids or liquids and other hazardous materials - Hazardous materials, as listed in appendix "C" shall not be disposed of in a sanitary landfill unless special provisions are made for such disposal through the Department.

13. Large items - Provisions shall be made for the disposal of large, heavy, or bulky items which lie within the capabilities of the site, as established by the registered licence holder or operator.

14. Burning - No garbage or refuse containing garbage or other putrescible material shall be burned at the sanitary landfill. Burning of select materials shall be severely restricted, and shall be conducted only with the permission of the Air Pollution Control Service.

15. Salvage - When salvaging is permitted, it shall be so organized that it will not interfere with prompt sanitary disposal of refuse or create unsightliness or health hazards. Scavenging shall not be permitted.

16. Insect and rodent control- Conditions for the prevention of insects and rodents shall be maintained by carrying out routine landfill operations promptly in a systematic manner. Supplemental insect and rodent control measures shall be instituted whenever necessary in the opinion of the medical officer of health.

17. Dust control - Suitable measures shall be taken on the site to control dust where this appears necessary in the opinion of the Department.

18. Drainage of surface water - The entire site, including the fill surface, shall be graded and provided with drainage facilities to minimize runoff onto and into the fill, to prevent erosion or washing of the fill, to drain off rainwater falling on the fill, and to prevent the collection of standing water.

19. Sub-surface drainage - Where necessary in the opinion of the Department, sub-surface drainage, collection and disposal of drainage in a manner satisfactory to the Department may be required.

20. Completion of landfill - An inspection of the entire site shall be made by a representative of the Department as to comply with the approved plans and specifications before the earth moving equipment is removed from the site. Any necessary corrective work shall be performed before the landfill project is accepted as completed.

21. Supervision of operation - A landfill operation shall be under the direction of a qualified individual. Said minimum qualifications to be established by the Department.

22. Animals - Domestic and wild animals shall be excluded from the site.

23. Inspection and evaluation - Routine inspections and evaluations of landfill operations shall be made by a representative of the Department. A written notice of any deficiencies, together with any recommendations for their correction, shall be provided to the Registered Licence Holder or operator responsible for the use of the land; and the appropriate individual, firm, or governmental agency responsible for the landfill operation.

24. Operational records - A daily log shall be maintained to record operational information, including the type and quantity of refuse received. Upon completion of the landfill site a map shall be filed with the Department showing the depth of fill, type of fill and location of hazardous material, as provided for in Item 12.

Municipal and Industrial Incinerator Standards

Section - 1 Design

1. Drawings and specifications, including site location, shall be submitted to the Department for approval. These shall be prepared by a Professional Engineer.

2. Plans will include details of routes to be used for hauling of raw refuse and ash disposal.

3. The submission will include projected tonnage and volume of raw refuse and of incinerated ash.

4. The submission will include details of storage capacity and projected maximum and minimum daily tonnage, and volume of raw refuse to be processed. The number of hours of daily operation will also be projected.

5. The submission will include an estimate of the qualitative and quantitative composition of the raw refuse.

6. Details will be submitted with respect to any scheme of salvage.

7. Information will be submitted with respect to staff, showing total of employees and distribution as to shift work and duties.

8. The drawings will include details of sanitary arrangements for personnel, including washing and locker facilities and lunch room arrangements.

9. The drawings will include information respecting facilities to obviate air pollution as defined by the Air Pollution Control Act.

10. The submission will include information respecting facilities to obviate water pollution as required by the Ontario Water Resources Commission Act.

Section 2 - Operations

1. Incineration will be carried out in a manner such that the chimney effluent will be in accord with the regulations under the Air Pollution Control Act.

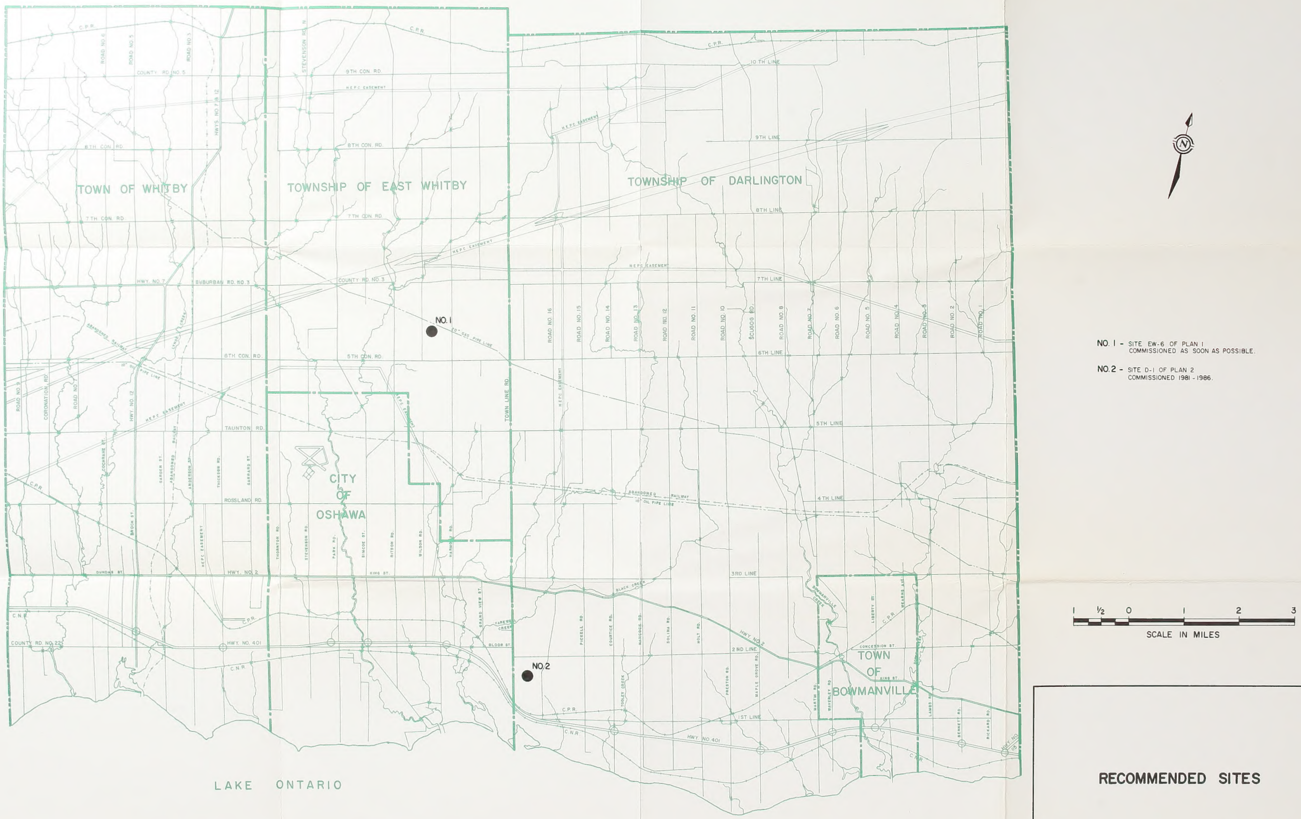
2. Storage of raw refuse will be under such conditions as to not develop a public nuisance, nor an unsightly appearance. Effective practices will be employed to control insects and rodents.

3. Incineration will be carried out to an extent that the organic and combustible content will be essentially completely consumed. The incinerator ash will be inspected and graded by the Department. Grade "A" will be accepted for use as open landfill, or for consolidation in land reclamation from water sites. Grade "B" containing incompletely oxidized or consumed putrescible matter will be restricted to sanitary landfill sites and procedures.

4. Proposals with respect to disposition of incinerator ash and other residues, and salvage will be submitted to the Department for approval in advance of their adoption.

5. Monthly reports will be submitted to the Department showing the disposition of incinerator ash with respect to tonnage, and location of disposal site.

6. Incinerator ash will be transported in covered trucks, with no spillage or leakage of quench water.



NO. 1 - SITE EW-6 OF PLAN 1
COMMISSIONED AS SOON AS POSSIBLE.

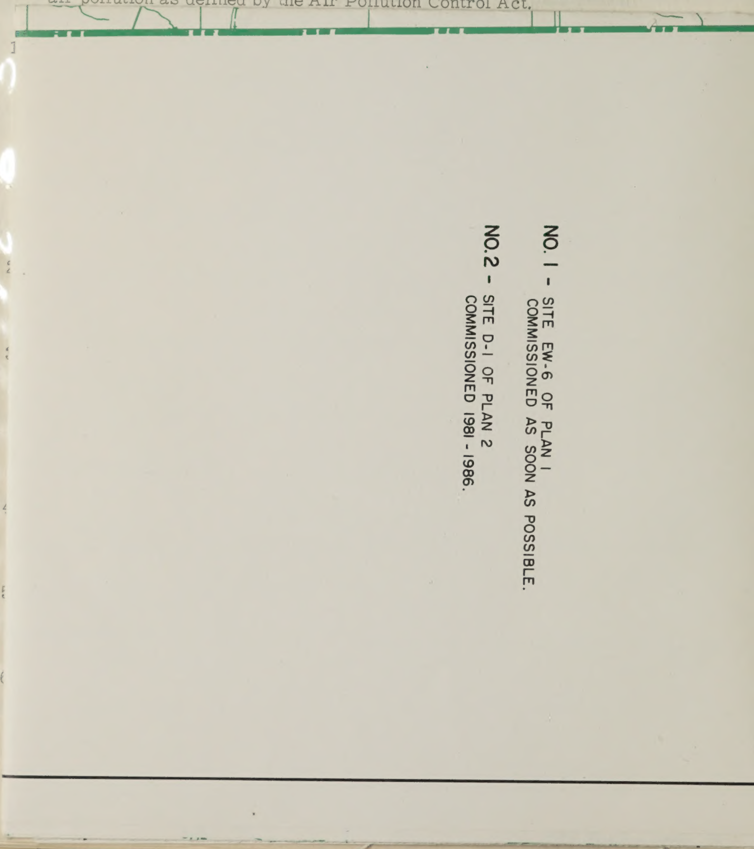
NO. 2 - SITE D-1 OF PLAN 2
COMMISSIONED 1981 - 1986.

RECOMMENDED SITES

FIG. XIII-1

8. The drawings will include details of sanitary arrangements for personnel, including washing and locker facilities and lunch room arrangements.

9. The drawings will include information respecting facilities to obviate air pollution as defined by the Air Pollution Control Act.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